# Final

# Total Maximum Daily Loads

# for

# Dissolved Oxygen & Nutrients

# in

# Hillsborough River (WBID 1443A)

# and Cow House Creek (1534)

# Dissolved Oxygen

# in Hillsborough River (WBID 1443B)

# and Nutrients

# in Hillsborough River (WBID 1443E)

**July 2013**

United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for dissolved oxygen and nutrients in the Tampa Bay Tributaries Basin (WBIDs 1443A, 1443B, 1534, 1443E). Subsequent actions must be consistent with this TMDL.

_____________/s/______________________________ __7/7/2013__

James D. Giattina, Director
Water Protection Division

Date

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## SUMMARY SHEET for WBID 1443A

## Total Maximum Daily Load (TMDL)

**2009 303(d) Listed Waterbodies for TMDLs addressed in this report:**

| WBID | Segment Name | Class and Waterbody Type | Major River Basin | HUC | County | State |
|---|---|---|---|---|---|---|
| 1443A | Hillsborough River | Class III Fresh | Tampa Bay Tributaries | 03100205 | Pasco-Hillsborough | Florida |

**TMDL Endpoints/Targets:**

Dissolved Oxygen and Nutrients

**TMDL Technical Approach:**

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model was used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

**TMDL Waste Load and Load Allocation**

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 78,558 | -- | 36,946 | -- | 53% | 53% |
| Total Phosphorus | -- | 7,651 | -- | 1119 | -- | 85% | 85% |
| Biochemical Oxygen Demand | -- | 70,284 | -- | 50,532 | -- | 28% | 28% |

**Endangered Species Present (Yes or Blank):** Yes

**USEPA Lead TMDL (USEPA or Blank):** USEPA

**TMDL Considers Point Source, Non-point Source, or Both:** Non-point

**Major NPDES Discharges to surface waters addressed in USEPA TMDL:**

| Permit ID | Permittee(s) | County | Permit Type |
|---|---|---|---|
| FLS000006 | Hillsborough County | Hillsborough | Phase I MS4 |
| FLS000015 | Polk County | Polk | Phase I MS4 |
| FLS000032 | Pasco County / City of Zephyrhills | Pasco | Phase I MS4 |

## SUMMARY SHEET for WBID 1443B

## Total Maximum Daily Load (TMDL)

**2009 303(d) Listed Waterbodies for TMDLs addressed in this report:**

| WBID | Segment Name | Class and Waterbody Type | Major River Basin | HUC | County | State |
|---|---|---|---|---|---|---|
| 1443B | Hillsborough River | Class I Fresh | Tampa Bay Tributaries | 03100205 | Pasco-Hillsborough | Florida |

**TMDL Endpoints/Targets:**

Dissolved Oxygen

**TMDL Technical Approach:**

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model was used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

**TMDL Waste Load and Load Allocation**

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 443,246 | -- | 225,723 | -- | 49% | 49% |
| Total Phosphorus | -- | 53,832 | -- | 8451 | -- | 84% | 84% |
| Biochemical Oxygen Demand | -- | 192,403 | -- | 141,301 | -- | 27% | 27% |

**Endangered Species Present (Yes or Blank):** Yes

**USEPA Lead TMDL (USEPA or Blank):** USEPA

**TMDL Considers Point Source, Non-point Source, or Both:** Non-point

**Major NPDES Discharges to surface waters addressed in USEPA TMDL:**

| Permit ID | Permittee(s) | County | Permit Type |
|---|---|---|---|
| FLS000006 | Hillsborough County | Hillsborough | Phase I MS4 |
| FLS000032 | Pasco County | Pasco | Phase I MS4 |

## SUMMARY SHEET for WBID 1443E

## Total Maximum Daily Load (TMDL)

**2009 303(d) Listed Waterbodies for TMDLs addressed in this report:**

| WBID | Segment Name | Class and Waterbody Type | Major River Basin | HUC | County | State |
|---|---|---|---|---|---|---|
| 1443E | Hillsborough River | Class III Marine | Tampa Bay Tributaries | 03100205 | Hillsborough | Florida |

**TMDL Endpoints/Targets:**

Nutrients

**TMDL Technical Approach:**

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

**TMDL Waste Load and Load Allocation**

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 357,542 | -- | 148,517 | -- | 58% | 58% |
| Total Phosphorus | -- | 78,035 | -- | 6169 | -- | 92% | 92% |
| Biochemical Oxygen Demand | -- | 153,503 | -- | 153,503 | -- | 0% | 0% |

**Endangered Species Present (Yes or Blank):** Yes

**USEPA Lead TMDL (USEPA or Blank):** USEPA

**TMDL Considers Point Source, Non-point Source, or Both:** Both

**Major NPDES Discharges to surface waters addressed in USEPA TMDL:**

| Permit ID | Permittee | County | Permit Type |
|---|---|---|---|
| FL0186651 | Lowry Park Zoological Garden – Africa Exhibit | Hillsborough | Commercial |
| FLS000006 | Hillsborough County | Hillsborough | Phase I MS4 |
| FLS000008 | City of Tampa | Hillsborough | Phase I MS4 |

## SUMMARY SHEET for WBID 1534

## Total Maximum Daily Load (TMDL)

**2009 303(d) Listed Waterbodies for TMDLs addressed in this report:**

| WBID | Segment Name | Class and Waterbody Type | Major River Basin | HUC | County | State |
|---|---|---|---|---|---|---|
| 1534 | Cow House Creek | Class I Fresh | Tampa Bay Tributaries | 03100205 | Hillsborough | Florida |

**TMDL Endpoints/Targets:**

Dissolved Oxygen and Nutrients

**TMDL Technical Approach:**

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model was used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

**TMDL Waste Load and Load Allocation**

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 11,132 | -- | 5,054 | -- | 55% | 55% |
| Total Phosphorus | -- | 753 | -- | 130 | -- | 83% | 83% |
| Biochemical Oxygen Demand | -- | 11,855 | -- | 7,640 | -- | 36% | 36% |

**Endangered Species Present (Yes or Blank):** Yes

**USEPA Lead TMDL (USEPA or Blank):** USEPA

**TMDL Considers Point Source, Non-point Source, or Both:** Non-point

**Major NPDES Discharges to surface waters addressed in USEPA TMDL:**

| Permit ID | Permittee(s) | County | Permit Type |
|---|---|---|---|
| FLS000006 | Hillsborough County | Hillsborough | Phase I MS4 |
| FLS000009 | City of Temple Terrace | Hillsborough | Phase I MS4 |

# 1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA 1991).

The Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into five groups and water quality is assessed in each group on a rotating five-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts.

For the purpose of planning and management, the WMD divided the districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBID) numbers are assigned to each water segment. This TMDL addresses WBIDs 1443A, 1443B, 1443E, and 1534, all of which are Group 2 waterbodies located in the Hillsborough River Planning Unit and are managed by the Southwest Florida Water Management District (SWFWMD). WBIDs 1443A and 1534 are impaired for dissolved oxygen and nutrients, WBID 1443B for dissolved oxygen, and WBID 1443E for nutrients.

# 2.0 PROBLEM DEFINITION

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). The IWR is FDEP's methodology for determining whether waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The TMDLs addressed in this document are being established pursuant to commitments made by the United States Environmental Protection Agency (USEPA) in the 1998 Consent Decree in the

Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). That Consent Decree established a schedule for TMDL development for waters listed on Florida's USEPA approved 1998 section 303(d) list. The 2009 section 303(d) list identified numerous WBIDs in the Hillsborough River Basin as not meeting WQS. After assessing all readily available water quality data, USEPA is responsible for developing a TMDL for WBIDs 1443A, 1443B, 1443E, and 1534, depicted in Figure 2.1. The parameters addressed for each WBID are listed in Table 2.1.

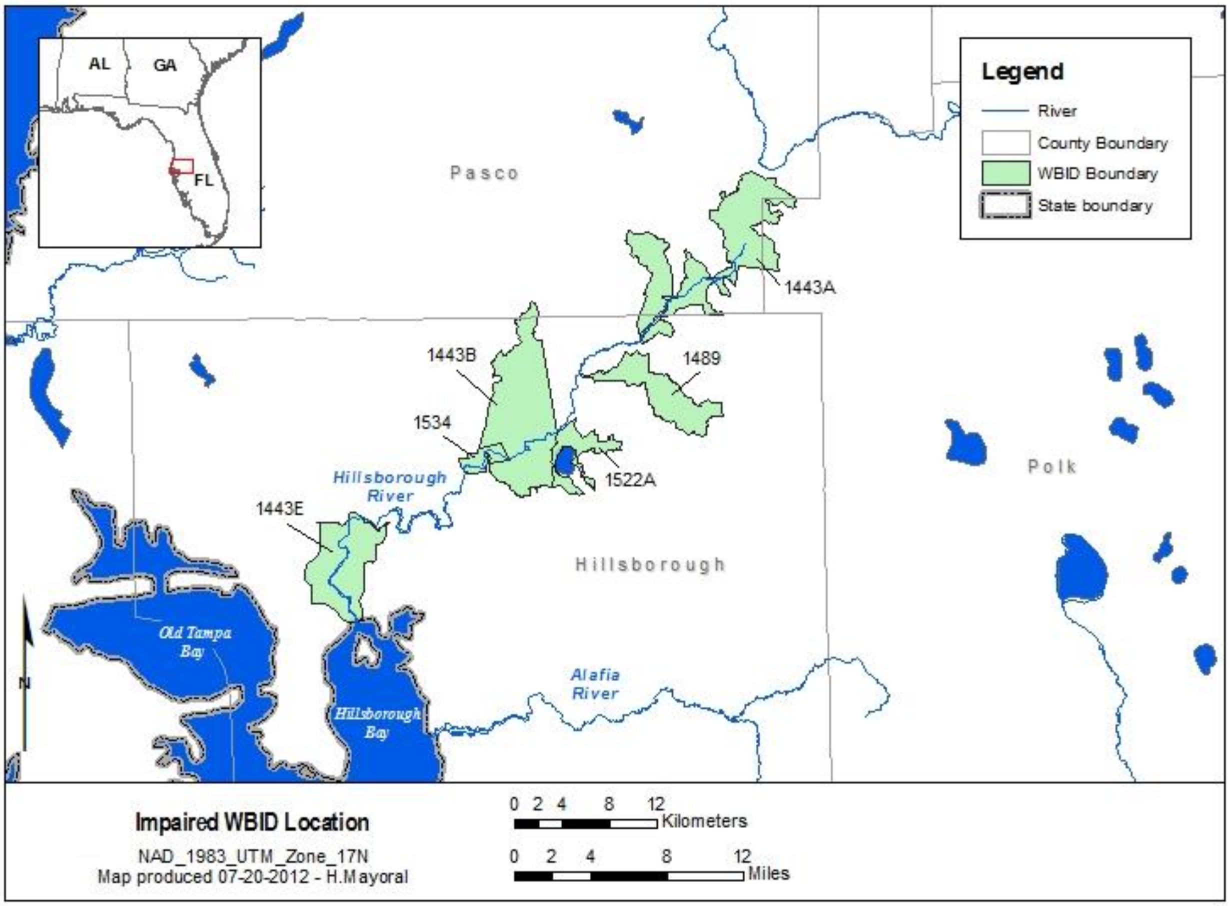


Figure 2.1 Location of the impaired WBID in the Hillsborough River basin

Table 2.1 Impaired WBIDs in the Hillsborough River basin.

| WBID | Segment Name | Class | Parameters | Planning Unit |
|---|---|---|---|---|
| 1443A | Hillsborough River | 3F | DO & Nutrients | Tampa Bay Tributaries |
| 1443B | Hillsborough River | 1 | DO | Tampa Bay Tributaries |
| 1443E | Hillsborough River | 3M | Nutrients | Tampa Bay Tributaries |
| 1534 | Cow House Creek | 1 | DO & Nutrients | Tampa Bay Tributaries |

# 3.0 WATERSHED DESCRIPTION

Tampa Bay is the largest open-water estuary in Florida, encompassing nearly 400 square miles and bordering three counties—Hillsborough, Manatee, and Pinellas. At 2,200 square miles, its watershed is more than five times larger than the bay itself (FDEP 2003). Tampa Bay proper, which includes Old, Middle, and Lower Tampa Bays and Hillsborough Bay, extends approximately 35 miles inland from the Gulf of Mexico and is 5 to 10 miles wide along most of its length. Four major causeways cross the bay. The bay averages only about 12 feet in depth, with the maximum natural depth of 89 feet found in a small area at its mouth in the Egmont Channel.

The Hillsborough River planning unit extends over parts of three counties, including much of the northeastern quarter of Hillsborough County, a large area of central Pasco County, and a small portion of northwestern Polk County. It is bound to the north by the Withlacoochee River watershed, to the east by the Peace River watershed, to the south by the Alafia River watershed, and to the west by the north coastal and Tampa Bay watersheds. WBIDs 1443A, 1443B, 1443E, and 1534 are all within the Hillsborough River planning unit. The Hillsborough River is referred to as an “Outstanding Florida Water” by the Florida Department of Environmental Protection, and has special protection under state law because of its natural attributes.

The Upper Hillsborough River (WBID 1443A) is located primarily within Pasco County with some of the lower reach in Hillsborough County and some of the upper reach in Polk County. The Upper Hillsborough River is a Class III waterbody with designated uses of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. It includes a segment of the Hillsborough River that is minimally disturbed, with a wide, vegetated riparian corridor bordered by pasture land and numerous small, isolated wetlands. The Upper Hillsborough River WBID covers a total of 16,665 acres with the dominant land use within the watershed identified as wetland area (33%). Urban and Built up areas account for 24%. Agriculture accounts for 17% with Rangeland and Forest making up the remaining area.

WBID 1443B includes a segment of the Hillsborough River just upstream of Interstate 75 in Hillsborough County. This segment of the Hillsborough River is minimally disturbed, surrounded by wooded, undeveloped land. The WBID includes some developed areas of Thonotosassa to the south of the river and Wesley Chapel to the north of the river.

WBID 1443E includes the most downstream reach of the Hillsborough River, from where the river crosses under Interstate 285, downstream to where it empties into Hillsborough Bay. The WBID is in a heavily developed area of the City of Tampa. The river has no floodplain wetlands or riparian buffer along this reach.

Cow House Creek, WBID 1534, is a tributary of Hillsborough River, as it meets with the Tampa Bypass Canal. Wetlands and developed land use are the two largest land use classification types within the WBID.

## *3.1 Hydrologic Characteristics*

The Hillsborough River Basin begins east-northeast of Zephyrhills in southeastern Pasco and northwestern Polk Counties. Its headwaters originate in the southwestern portion of the Green Swamp, where it also receives overflow from the Withlacoochee River. The river channel is not clearly defined until the river leaves the swamp. From there, it flows southwesterly 54 miles to upper Hillsborough Bay and drains more than 690 square miles.

### *3.2 Climate*

The climate in this part of the county is sub-tropical. Based on a weather station located in Plant City (Latitude 28.2 degree, Longitude -82.14 degree), the annual rainfall for the area averaged about 51.17 inches for a 30-year period from 1971 through 2000. The average summer temperature (from June through August) is 81.1°F, and the average winter temperature is 62.3°F.

### *3.3 Land Use*

In WBID 1443A, at the headwaters of the Hillsborough River, the majority of the land use is classified as wetlands. Both forested and non-forested wetlands combined account for 32 percent of the total land use within the WBID, followed by developed land use at 23 percent. There are nearly equal portions of combined forest and pastures as well, each accounting for approximately 16 to 17 percent of the total land use. Forested areas are situated along the Hillsborough River corridor, just east of the City of Zephyrhills. Areas of clear cut/sparse land use located primarily east of the Hillsborough River, account for 9 percent of the total land use with the WBID.

Forested and non-forested wetlands make up the majority of the land use within WBID 1443B, accounting for 37 percent of the total land use. The wetlands run along the riparian corridor of the Hillsborough River as it runs through Flatwoods Wilderness Park. Combined forest throughout the area comprises an additional 17 percent of the total land use. Only about a quarter of the WBID is developed, primarily from the surrounding cities of Wesley Chapel and Thonotosassa. There are small areas of pasture in the northern portion of the WBID, which accounts for an additional 8 percent of the total land use.

Developed land use is most prevalent in WBID 1443E, comprising 96 percent of the total land use. A majority of the developed land use within WBID 1443E consists of high-intensity development, as it encompasses a large portion of the City of Tampa. The Hillsborough River runs through the City of Tampa, crediting open water for an additional 3 percent of the total land use. The remaining 2 percent of total land use is attributed equally to combined forest land use and combined forested and non-forested wetlands.

WBID 1534 contains within its boundary, a length of Cow House Creek, a tributary of Hillsborough River, as it meets with the Tampa Bypass Canal. Wetlands and developed land use are the two largest land use classification types within the WBID, each accounting for 22 percent of the total land use. Combined forest along the riparian corridor of Cow House Creek is credited an additional 23 percent of the total land use. There are also small areas of pastures north of the headwaters of Cow House Creek.

The actual drainage area for each of the WBIDs varies from their boundaries. The United States Geological Survey National Hydrography Dataset was used to delineate the drainage area. A listing of the subwatersheds contributing to each of the WBIDs is listed in Table 3.2, and illustrated in Figure 3.2. The cumulative land use distributions contributing to each of the WBIDs, is broken down in Table 3.3. Acreage and land use distributions between the drainage area for each of the WBIDs and their boundaries varied considerably. In most WBIDs, the drainage area increased the acreage that contributes to each of the WBIDs. WBID 1443E, located at the base of the Hillsborough River where it drains into Hillsborough Bay, has a drainage area that includes the entire Hillsborough River watershed, which is approximately 399,875 acres.

Developed land use remains the largest land use classification type contributing to most of the WBIDs, ranging from 27 percent (WBID 1443A) to 48 percent (WBID 1534) of the total contributing area. In addition to increases in developed land uses, there were also substantial increases in combined forest, pastures, combined forested and non-forested wetlands, and open water land uses.

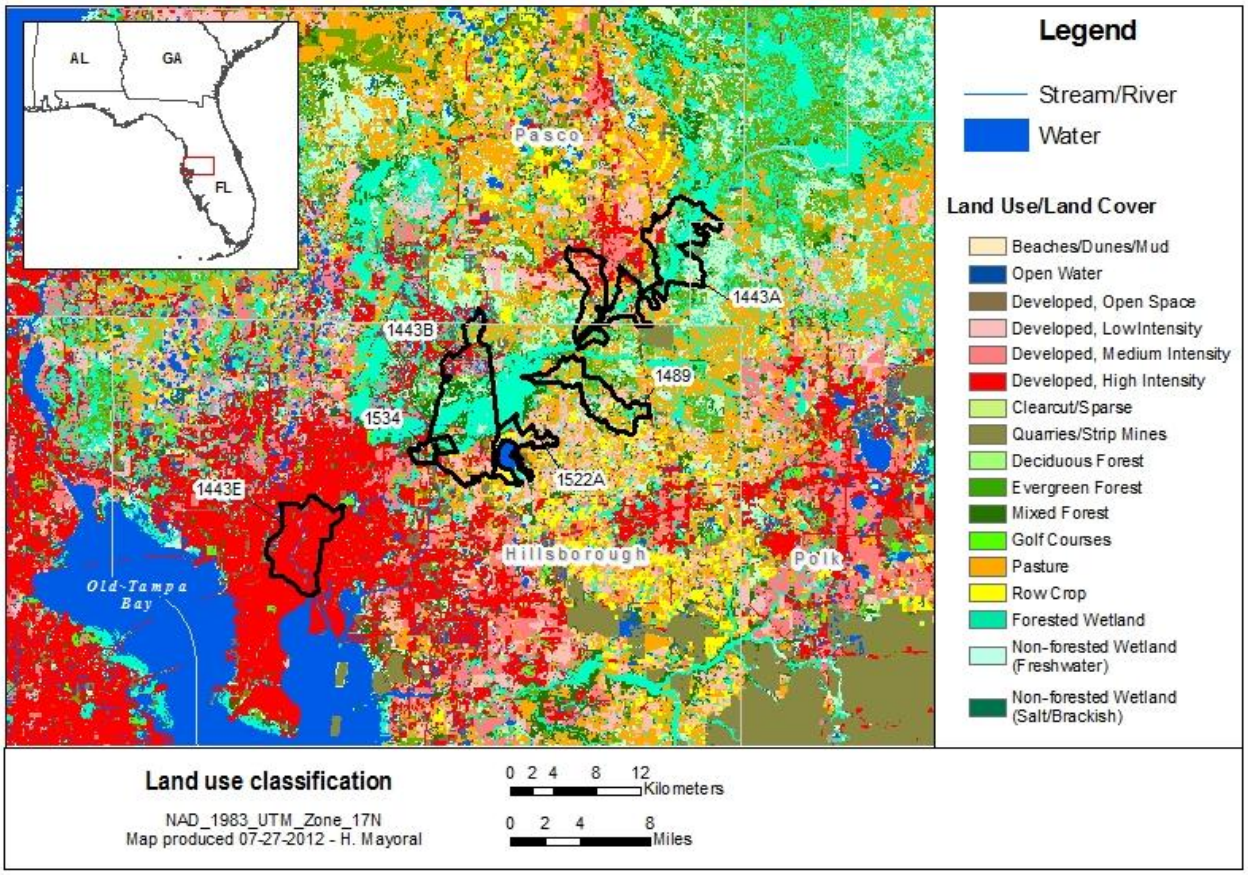


Figure 3.1 Land use for the impaired WBID in the Hillsborough River basin

Table 3.1 Land use distribution for the impaired WBIDs in the Hillsborough River basin

| Land Use Classification | WBID 1443A | | WBID 1443B | | WBID 1443E | | WBID 1534 | |
|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % |
| Evergreen Forest | 1388 | 9% | 432 | 3% | 0 | 0% | 0 | 0% |
| Deciduous Forest | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Mixed Forest | 1245 | 8% | 2305 | 15% | 51 | 1% | 327 | 23% |
| Forested Wetland | 4567 | 28% | 5176 | 33% | 44 | 0% | 421 | 29% |
| Non-Forested Wetland (Freshwater) | 696 | 4% | 586 | 4% | 14 | 0% | 45 | 3% |
| Open Water | 64 | 0% | 451 | 3% | 296 | 3% | 35 | 2% |
| Pasture | 2787 | 17% | 1312 | 8% | 0 | 0% | 100 | 7% |
| Row Crop | 121 | 1% | 185 | 1% | 2 | 0% | 0 | 0% |
| Clear cut Sparse | 1492 | 9% | 771 | 5% | 0 | 0% | 0 | 0% |
| Quarries Strip mines | 248 | 2% | 170 | 1% | 0 | 0% | 27 | 2% |
| Utility Swaths | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Developed, Open Space | 295 | 2% | 516 | 3% | 491 | 5% | 93 | 6% |
| Developed, Low intensity | 1754 | 11% | 1057 | 7% | 34 | 0% | 87 | 6% |
| Developed, medium intensity | 369 | 2% | 1015 | 6% | 85 | 1% | 37 | 3% |
| Developed, High intensity | 1297 | 8% | 1627 | 10% | 8233 | 89% | 259 | 18% |
| Beaches/Dunes/Mud | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Golf Courses | 0 | 0% | 99 | 1% | 0 | 0% | 0 | 0% |
| Totals | 16323 | 100% | 15702 | 100% | 9250 | 100% | 1431 | 100% |

Table 3.2 Contributing subwatersheds listed by WBID

| 1443A | 1443B | 1443E | 1534 |
|---|---|---|---|
| 1076-1088 | 1068-70 | 1061 | 1067 |
| | 1072-90 | 1062 | |
| | 1636-42 | 1067-70 | |
| | 1671-73 | 1072-88 | |
| | 1677-80 | 1090 | |
| | 1684 | 1636-45 | |
| | 1692 | 1668 | |
| | 1693 | 1671-73 | |
| | | 1675-80 | |
| | | 1684 | |
| | | 1692-94 | |

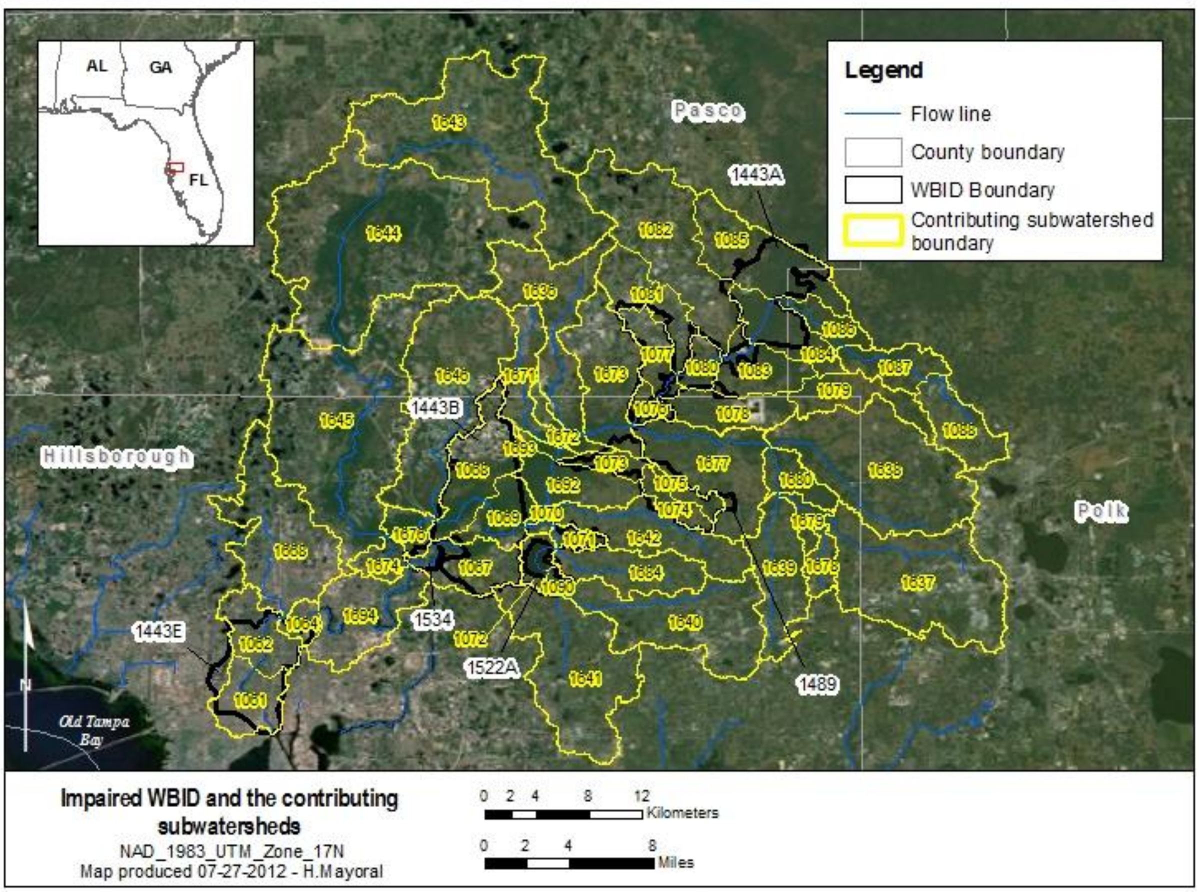


Figure 3.2 Aerial photograph illustrating contributing subwatershed and impaired WBID boundaries

Table 3.3 Land use distribution for contributing subwatersheds in the Hillsborough River basin

| Land Use Distribution | WBID 1443A | | WBID 1443B | | WBID 1443E | | WBID 1534 | |
|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % |
| Evergreen Forest | 5,322 | 7% | 11,588 | 5% | 16,236 | 4% | 60 | 1% |
| Deciduous Forest | 90 | 0% | 90 | 0% | 199 | 0% | 0 | 0% |
| Mixed Forest | 4,044 | 5% | 14,663 | 6% | 23,739 | 6% | 742 | 13% |
| Forested Wetland | 11,672 | 16% | 36,088 | 15% | 62,211 | 16% | 841 | 15% |
| Non-Forested Wetland (Freshwater) | 3,251 | 4% | 14,380 | 6% | 23,960 | 6% | 102 | 2% |
| Open Water | 824 | 1% | 5,044 | 2% | 10,739 | 3% | 92 | 2% |
| Pasture | 16,741 | 23% | 59,504 | 24% | 86,300 | 22% | 885 | 15% |
| Row Crop | 2,909 | 4% | 12,872 | 5% | 17,098 | 4% | 150 | 3% |
| Clear cut / Sparse | 6,363 | 9% | 12,622 | 5% | 15,541 | 4% | 12 | 0% |
| Quarries Strip mines | 2,320 | 3% | 1,903 | 1% | 4,007 | 1% | 143 | 2% |
| Utility Swaths | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Developed, Open Space | 1,910 | 3% | 7,556 | 3% | 12,121 | 3% | 338 | 6% |
| Developed, Low intensity | 8,587 | 12% | 30,306 | 12% | 41,192 | 10% | 1,141 | 20% |
| Developed, medium intensity | 3,553 | 5% | 16,157 | 7% | 27,117 | 7% | 462 | 8% |
| Developed, High intensity | 6,000 | 8% | 21,904 | 9% | 56,176 | 14% | 798 | 14% |
| Beaches/Dunes/Mud | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Golf Courses | 698 | 1% | 1,992 | 1% | 3,237 | 1% | 0 | 0% |
| Totals | 74,284 | 100% | 246,672 | 100% | 399,875 | 100% | 5,766 | 100% |

# 4.0 WATER QUALITY STANDARDS/TMDL TARGETS

The TMDL reduction scenarios were done to achieve Florida's dissolved oxygen concentration of 5 mg/L and ensure balanced flora and fauna within these WBIDs or establish the TMDL to be consistent with a natural condition if the dissolved oxygen standard cannot be achieved.

## *4.1 Designated Uses*

Florida has classified its waters based on the designated uses those waters are expected to support. Waters classified as Class I waters are designated for Potable Water Supply; Class II waters are designated for Shellfish Propagation or Harvesting, and Class III waters are designated for Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Designated use classifications are described in Florida's water quality standards at section 62-302.400, F.A.C.

The waterbodies addressed in this report are either Class I or Class III waters. WBIDs 1443B and 1534 are Class I Freshwater, while the rest (WBIDs 1443A and 1443E) are Class III Freshwater and Marine.

## *4.2 Water Quality Criteria*

Water quality criteria for protection of all classes of waters are established in Section 62-302.530, F.A.C. Individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C., which established minimum criteria that apply to all waters unless alternative criteria are specified. Section 62-302.530, F.A.C. Several of the WBIDs addressed in this report were listed due to elevated concentrations of chlorophyll *a*. While FDEP does not have a streams water quality standard specifically for chlorophyll *a*, elevated levels of chlorophyll *a* are frequently associated with nonattainment of the narrative nutrient standard, which is described below.

## *4.3 Nutrient Criteria*

In 1979, FDEP adopted a narrative criterion for nutrients. FDEP recently adopted numeric nutrient criteria for many Class III waters in the state, including streams, lakes, springs, and estuaries, which numerically interprets part of the state narrative criterion for nutrients. On November 30, 2012, EPA approved those criteria as consistent with the requirements of the CWA. Estuary specific criteria for a number of estuaries, as set out in 62-302.532(1), are effective for state law purposes. The remainder of the state criteria, however, are not yet effective for state law purposes.

In December 2010, EPA promulgated numeric nutrient criteria for Class I/III inland waters in Florida, including lakes and streams. On February 18, 2012, the federally promulgated criteria for lakes and springs were upheld by the U.S. District Court for the Northern District of Florida. Those criteria became effective on January 7, 2013. The Court invalidated the streams criteria and remanded those criteria back to EPA. EPA reproposed the streams criteria on November 30, 2012.

Therefore, for lakes and springs in Florida, the applicable nutrient water quality criteria for CWA purposes are the federally promulgated criteria. For those estuaries identified in 62-302.532(1), the applicable nutrient water quality criteria for CWA purposes are FDEP's estuary criteria. For streams and the remaining estuaries in Florida, the applicable nutrient water quality standard for CWA purposes remains Florida's narrative nutrient criterion.

### 4.3.1 Narrative Nutrient Criteria

Florida's narrative nutrient criteria for Class I, II, and III waters provide:

> The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man induced nutrient enrichment (total nitrogen and total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242. Section 62-302.530(47)(a), F.A.C.
>
> In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Section 62-302.530(47)(b), F.A.C.

Chlorophyll and DO levels are often used to indicate whether nutrients are present in excessive amounts. The target for this TMDL is based on levels of nutrients necessary to prevent violations of Florida's DO criterion, set out below.

### 4.3.2 Inland Nutrient Criteria for streams

Florida's recently adopted numeric nutrient criteria interprets the narrative water quality criterion for nutrients in paragraph 62-302.530(48)(b), F.A.C. See section 62-302.531(2). While not yet effective as water quality criteria, the FDEP's numeric nutrient criteria represent the state's most recent interpretation of the second part of Florida's narrative criteria, set out at paragraph 62-302.530(47)(b), F.A.C. See section 62-302.531(2). Unless otherwise stated, where the EPA refers to the state nutrient rule in this TMDL, that rule is referenced as the state's interpretation of the narrative criterion. In addition, the first part of the narrative criteria, at paragraph 62-302.530(47)(a), F.A.C., also remains applicable to all Class I, II and III waters in Florida.

Florida's rule applies to streams. For streams that do not have a site specific criteria, Florida's rule provides for biological information to be considered together with nutrient thresholds to determine whether a waterbody is attaining 62-302.531(2)(c), F.A.C. The rule provides that the nutrient criteria are attained in a stream segment where information on chlorophyll a levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition indicates there are no imbalances in flora and either the average score of at least two temporally independent SCIs performed at representative locations and times is 40 or higher, with neither of the two most recent SCI scores less than 35, or the nutrient thresholds set forth in Table 1 below are achieved. See section 62-302.531(2)(c).

Florida's rule provides that numeric nutrient criteria are expressed as a geometric mean, and concentrations are not to be exceeded more than once in any three calendar year period. Section 62-302.200 (25)(e), F.A.C.

Table 4.1 Inland numeric nutrient criteria

| Nutrient Watershed Region | Total Phosphorus Nutrient Threshold | Total Nitrogen Nutrient Threshold |
|---|---|---|

| | | |
|---|---|---|
| Panhandle West | 0.06 mg/L | 0.67 mg/L |
| Panhandle East | 0.18 mg/L | 1.03 mg/L |
| North Central | 0.30 mg/L | 1.87 mg/L |
| Peninsular | 0.12 mg/L | 1.54 mg/L |
| West Central | 0.49 mg/L | 1.65 mg/L |
| South Florida | No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies. | No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies. |

### 4.3.3 Inland Nutrient Criteria for estuaries with effective criteria

Numeric criteria for estuaries are expressed as either concentration-based estuary interpretations that are open water, area-wide averages or as load per million cubic meters of freshwater inflow that are the total load of that nutrient to the estuary divided by the total volume of freshwater inflow to that estuary. The criteria are set out at 62-302.532(1).

### 4.3.4 Inland Nutrient Criteria for lakes

Federal water quality criteria for lakes set out at 40 CFR 131.43(c)(1). The criteria are expressed as concentrations of chlorophyll a, total phosphorus, and total nitrogen as follows:

| Lake Color and Alkalinity | Chl-a (mg/L)* | TN (mg/L) | TP (mg/L) |
|---|---|---|---|
| Colored Lakes<br>(Long-term Color > 40 Platinum Cobalt Units (PCU) | 0.020 | 1.27<br>[1.27-2.23] | 0.05<br>[0.05-0.16] |
| Clear Lakes, High Alkalinity<br>(Long-term Color ≤ 40 PCU and Alkalinity > 20 mg/L $CaCO_3$) | 0.020 | 1.05<br>[1.05-1.91] | 0.03<br>[0.03-0.09] |
| Clear Lakes, Low Alkalinity<br>(Long-term Color ≤ 40 PCU and Alkalinity ≤ 20 mg/L $CaCO_3$) | 0.006 | 0.51<br>[0.51-0.93] | 0.01<br>[0.01-0.03] |

* For a given waterbody, the annual geometric mean of chlorophyll *a*, TN or TP concentrations shall not exceed the applicable criterion concentration more than once in a three-year period.

### 4.3.5 Springs Nutrient Criteria

The numeric criteria for spring is 0.35 mg/L of nitrate-nitrite as an annual geometric mean, not to be exceeded more than once in any three year period.

## *4.4 Dissolved Oxygen Criteria*

Numeric criteria for DO are expressed in terms of minimum and daily average concentrations. While FDEP has adopted revised DO criteria for freshwaters, these revisions have not yet been submitted to EPA for review. Therefore, the applicable criterion for Clean Water Act purposes remains subsection 62-302.530(30), F.A.C.

**For Class I and Class III freshwaters**, subsection 62-302.530(30) provides as follows:

Shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. [FAC 62-302.530 (30)]

**For Class III marine waters**, subsection 62-302.530(30) provides as follows:

Shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. [FAC 62-302.530 (30)]

## *4.5 Biochemical Oxygen Demand Criteria*

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions. [FAC 62-302.530 (11)]

## *4.6 Natural Conditions*

In addition to the standards for nutrients, DO, and BOD described above, Florida's standards include provisions that address waterbodies which do not meet the standards due to natural background conditions.

Florida's water quality standards provide a definition of natural background:

"Natural Background" shall mean the condition of waters in the absence of man-induced alterations based on the best scientific information available to the Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody or on historical pre-alteration data. [FAC 62-302.200(19)]

Florida's water quality standards also provide that:

Pollution which causes or contributes to new violations of water quality standards or to continuation of existing violations is harmful to the waters of this State and shall not be allowed. Waters having water quality below the criteria established for them shall be protected and enhanced. However, the Department shall not strive to abate natural conditions. [FAC 62-302.300(15)]

# 5.0 WATER QUALITY ASSESSMENT

The WBIDs addressed in this report were listed as not attaining their designated use on Florida's 2009 303(d) list for either one or all of the following: biological oxygen demand, dissolved oxygen and nutrients. To determine impairment, an assessment of available data was conducted. The source for current ambient monitoring data was the Impaired Waters Rule (IWR) data Run 44, using data ranging from January 1, 2002 to December 31, 2010. The IWR database contains data from various sources within the state of Florida, including the WMDs and counties.

## *5.1 Water Quality Data*

A complete list of water quality monitoring station locations within the impaired WBIDs is located in Table 5.1, and an analysis of water quality data is documented in Table 5.2. Figure 5.1 through Figure 5.3 shows the locations of the water quality monitoring stations within each of the WBIDs. Water quality data for the WBIDs can be found below in Figure 5.4 through Figure 5., with the data from all water quality stations compiled in each figure.

### 5.1.1 Dissolved Oxygen

There are several factors that affect the concentration of DO in a waterbody, and natural DO levels are a function of water temperature, water depth and velocity, salinity and relative contributions from groundwater. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of higher DO water (e.g. from tributaries). DO concentrations can be lowered by processes that use up oxygen from the water, such as respiration and decomposition, and can be lowered through additions of water with lower DO (e.g. swamp or groundwater). Decomposition of organic matter, such as dead plants and animals, also consume DO. The minimum DO concentrations ranged between 0.2 mg/L and 0.3 mg/L in WBIDs 1443A and 1443B; with the lowest minimum concentration occurring in WBID 1443E, measuring 0.05 mg/L. Mean DO concentrations for all of the WBIDs were well below 5 mg/L, and were lowest in WBID 1534, at 2.85 mg/L.

### 5.1.2 Biochemical Oxygen Demand

BOD is a measure of the amount of oxygen used by bacteria as they stabilize organic matter. The process can be accelerated when there is an overabundance of nutrients, increasing the aerobic bacterial activity in a waterbody. In turn, the levels of DO can become depleted, eliminating oxygen essential for biotic survival, and potentially causing extensive fish kills. Additionally, BOD is used as an indicator to determine the presence and magnitude of organic pollution from sources such as septic tank leakage, fertilizer runoff, and wastewater effluent. Maximum BOD concentrations were greater than 8.0 mg/L in WBID 1443E. WBIDs 1443A and 1534 had maximum BOD measurements which ranged between 4.0 mg/L and 4.5 mg/L. The lowest BOD measurement occurred in WBID 1443B, measuring 2.2 mg/L. Mean BOD concentrations within all the WBIDs were less than 4.0 mg/L, and were lowest in WBID 1443B at 0.92 mg/L.

### 5.1.3 Nutrients

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating. For the nutrient assessment, the monitoring data for total nitrogen, total phosphorus and chlorophyll a are presented.

##### 5.1.3.1 Total Nitrogen

Total Nitrogen (TN) is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen (NH4). Though nitrogen is a necessary nutrient required for the growth of most plants and animals, not all forms are readily used or metabolized. Increased levels of organic nitrogen can occur from the decomposition of aquatic life or from sewage, while inorganic forms are generally from erosion and fertilizers. Nitrates are components of industrial fertilizers, yet can also be naturally present in soil, and are converted to nitrite by microorganisms in the environment. Surface runoff from agricultural lands can increase the natural presence of nitrates in the environment and can lead to eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by depletion in DO concentrations as a result of algal decomposition. Maximum total nitrogen concentrations were greater than 2 mg/L in all WBIDs. WBID 1443A had the highest total nitrogen maximum concentration, measuring 6.11 mg/L. Minimum total nitrogen concentrations were never less than 0.10 mg/L in any of the WBIDs, and mean total nitrogen concentrations never fell below 0.8 mg/L (WBID 1443E). Mean total concentrations mainly ranged between 1.0 mg/L and 1.4 mg/L.

##### 5.1.3.2 Total Phosphorus

In natural waters, total phosphorus exists in either soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which depletes oxygen in the water. Maximum total phosphorus concentration measured as high as 1.61 mg/L in WBID 1443A. The maximum total phosphorus concentrations ranged between 0.44 mg/L and 0.86 mg/L for the remaining WBIDs. Mean total phosphorus concentrations for all of the WBIDs did not exceed 0.50 mg/L, ranging between 0.18 mg/L and 0.46 mg/L.

##### 5.1.3.3 Chlorophyll-a

Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-*a* is a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-*a* measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region. It is used as a proxy indicator of water quality because of its predictable response to nutrient availability. Increases in nutrients can potentially lead to blooms in phytoplankton biomass, affecting water quality and ecosystem health. The greatest corrected chlorophyll-a maximum concentration was found in WBID 1443E, which reached a maximum of nearly 260 µg/L. WBIDs 1443A and 1443B, all had a maximum corrected chlorophyll-a concentration between 16 µg/L and 24 µg/L, while WBID 1534 had a maximum concentration of 70 µg/. Mean corrected chlorophyll-a concentrations ranged between 2.88 µg/L and 65.6 µg/L.

Table 5.1 Water quality stations located in the impaired WBIDs

| WBID | Station Number | WBID | Station Number |
|---|---|---|---|
| 1443A | 112WRD 02301988 | 1443E | 21FLHILL002 |
| | 112WRD 02301990 | | 21FLHILL137 |
| | 112WRD 02311000 | | 21FLHILL152 |
| | 112WRD 281205082080200 | | 21FLHILL176 |
| | 112WRD 281251082074900 | | 21FLKWATHIL-HILLSB112-1 |
| | 21FLTPA 24030001 | | 21FLKWATHIL-RIVER-101-1 |
| | 21FLTPA 24030013 | | 21FLKWATHIL-RIVER-101-2 |
| | 21FLTPA 24030048 | | 21FLKWATHIL-RIVER-101-3 |
| | 21FLTPA 281144308209378 | | 21FLKWATHIL-RIVER-103-1 |
| 1443B | 112WRD 02303330 | | 21FLKWATHIL-RIVER-103-2 |
| | 21FLHILL165 | | 21FLKWATHIL-RIVER-103-3 |
| | 21FLKWATHIL-HIIVER108-1 | | 21FLTBW HR100016 |
| | 21FLKWATHIL-HIIVER108-2 | | 21FLTBW HR100017 |
| | 21FLKWATHIL-HIIVER108-3 | | 21FLTBW HR100026 |
| | 21FLKWATHIL-HIIVER109-1 | | 21FLTBW HR100031 |
| | 21FLKWATHIL-HIIVER109-2 | | 21FLTBW HR100034 |
| | 21FLKWATHIL-HIIVER109-3 | | 21FLTBW HR100035 |
| | 21FLKWATHIL-HIIVER126-1 | | 21FLTBW HR100038 |
| | 21FLKWATHIL-HIIVER126-2 | | 21FLTPA 280046708227560 |
| | 21FLKWATHIL-HIIVER126-3 | 1534 | 21FLTPA 28032978221181 |
| | 21FLKWATHIL-HILLSB108-1 | | 21FLTPA 280329782215268 |
| | 21FLKWATHIL-HILLSB108-2 | | 21FLTPA 28044858220485 |
| | 21FLKWATHIL-HILLSB108-3 | | |
| | 21FLKWATHIL-RIVER-118-1 | | |
| | 21FLKWATHIL-RIVER-118-2 | | |
| | 21FLKWATHIL-RIVER-118-3 | | |
| | 21FLTPA 24030045 | | |
| | 21FLTPA 24030077 | | |
| | 21FLTPA 28045778217077 | | |
| | 21FLTPA 28051188220016 | | |
| | 21FLTPA 28055678218427 | | |
| | | | |

Table 5.2 Water quality data for the impaired WBIDs

| Parameter | Stats | WBID | | | |
|---|---|---|---|---|---|
| | | 1443A | 1443B | 1443E | 1534 |
| BOD, 5 Day, 20°C (mg/L) | # of obs | 17 | 45 | 274 | 21 |
| | min | 0.62 | 0.00 | 0.00 | 2.00 |
| | max | 4.00 | 2.20 | 8.00 | 4.00 |
| | mean | 1.95 | 0.92 | 1.55 | 2.19 |
| | Geomean | 1.77 | 0.53 | 1.06 | 2.15 |
| DO, Analysis by Probe (mg/L) | # of obs | 113 | 281 | 1027 | 20 |
| | min | 0.23 | 0.27 | 0.05 | 0.60 |
| | max | 10.70 | 9.60 | 10.02 | 9.53 |
| | mean | 4.34 | 4.75 | 3.93 | 2.85 |
| | Geomean | 3.78 | 4.11 | 2.93 | 2.03 |
| Nitrogen, Total (mg/L as N) | # of obs | 103 | 416 | 464 | 19 |
| | min | 0.22 | 0.32 | 0.12 | 0.29 |
| | max | 6.11 | 2.62 | 2.95 | 2.11 |
| | mean | 1.28 | 1.08 | 0.80 | 1.36 |
| | Geomean | 1.13 | 1.03 | 0.73 | 1.20 |
| Phosphorus, Total (mg/L as P) | # of obs | 100 | 419 | 468 | 21 |
| | min | 0.03 | 0.04 | 0.04 | 0.05 |
| | max | 1.61 | 0.64 | 0.44 | 0.86 |
| | mean | 0.18 | 0.25 | 0.20 | 0.46 |
| | Geomean | 0.12 | 0.21 | 0.18 | 0.35 |
| Chlorophyll-A-corrected (µg/L) | # of obs | 24 | 82 | 228 | 20 |
| | min | 1.00 | 1.00 | 1.00 | 1.00 |
| | max | 16.00 | 24.00 | 259.20 | 70.00 |
| | mean | 2.88 | 4.26 | 14.99 | 16.45 |
| | Geomean | 1.82 | 2.89 | 7.76 | 7.38 |

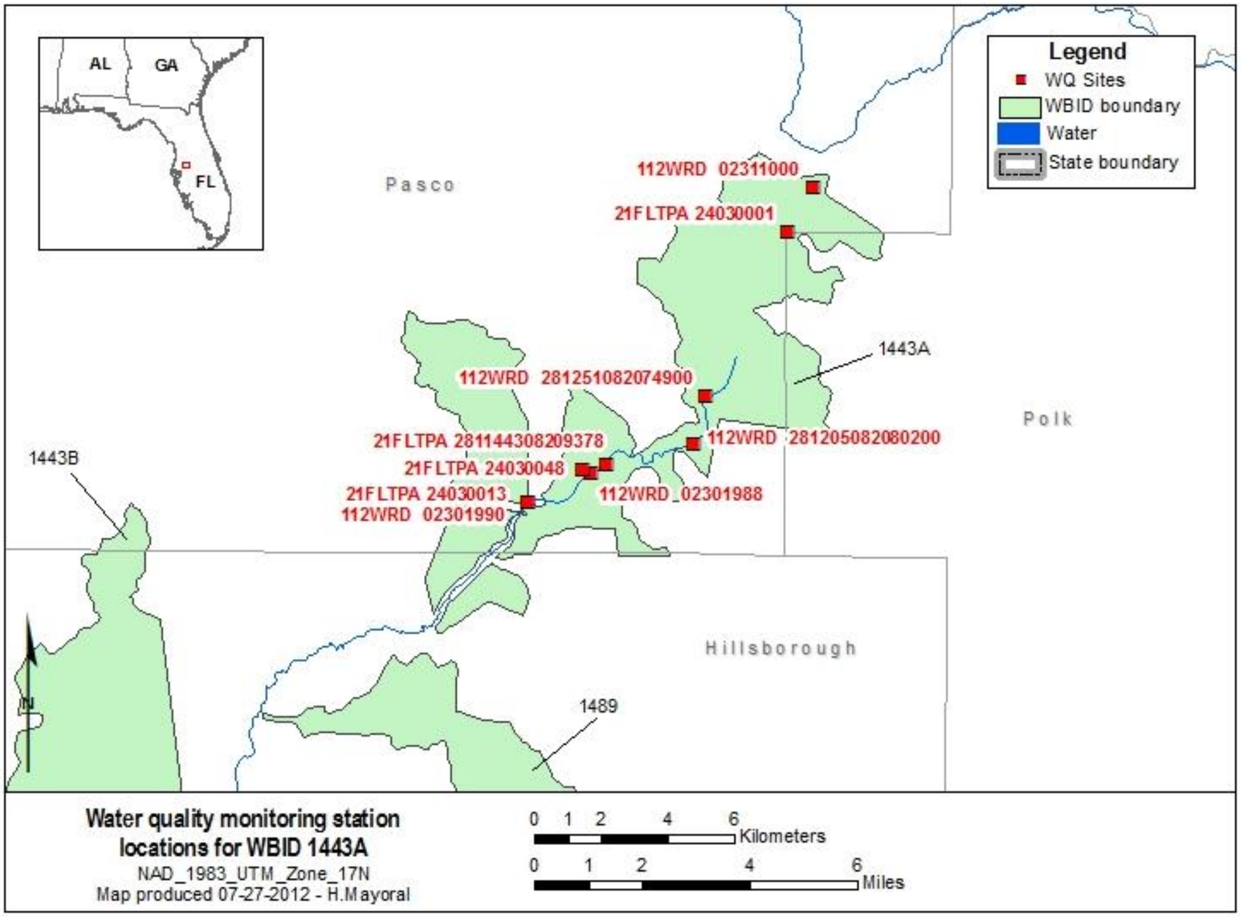


Figure 5.1 Water quality monitoring station locations for impaired WBID 1443A in the Hillsborough River basin

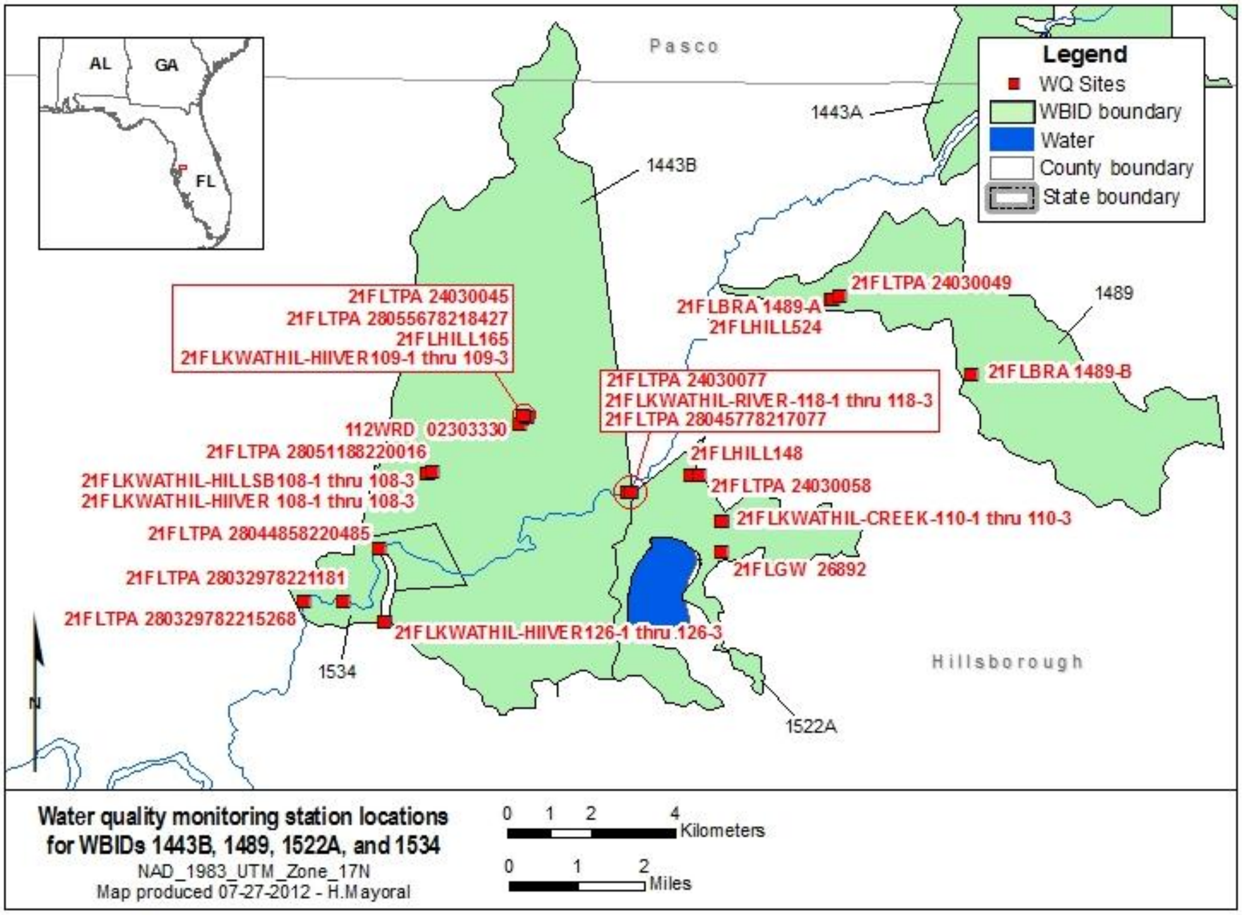


Figure 5.2 Water quality monitoring station locations for WBIDs 1443B, 1489, 1522A, and 1534 in the Hillsborough River basin

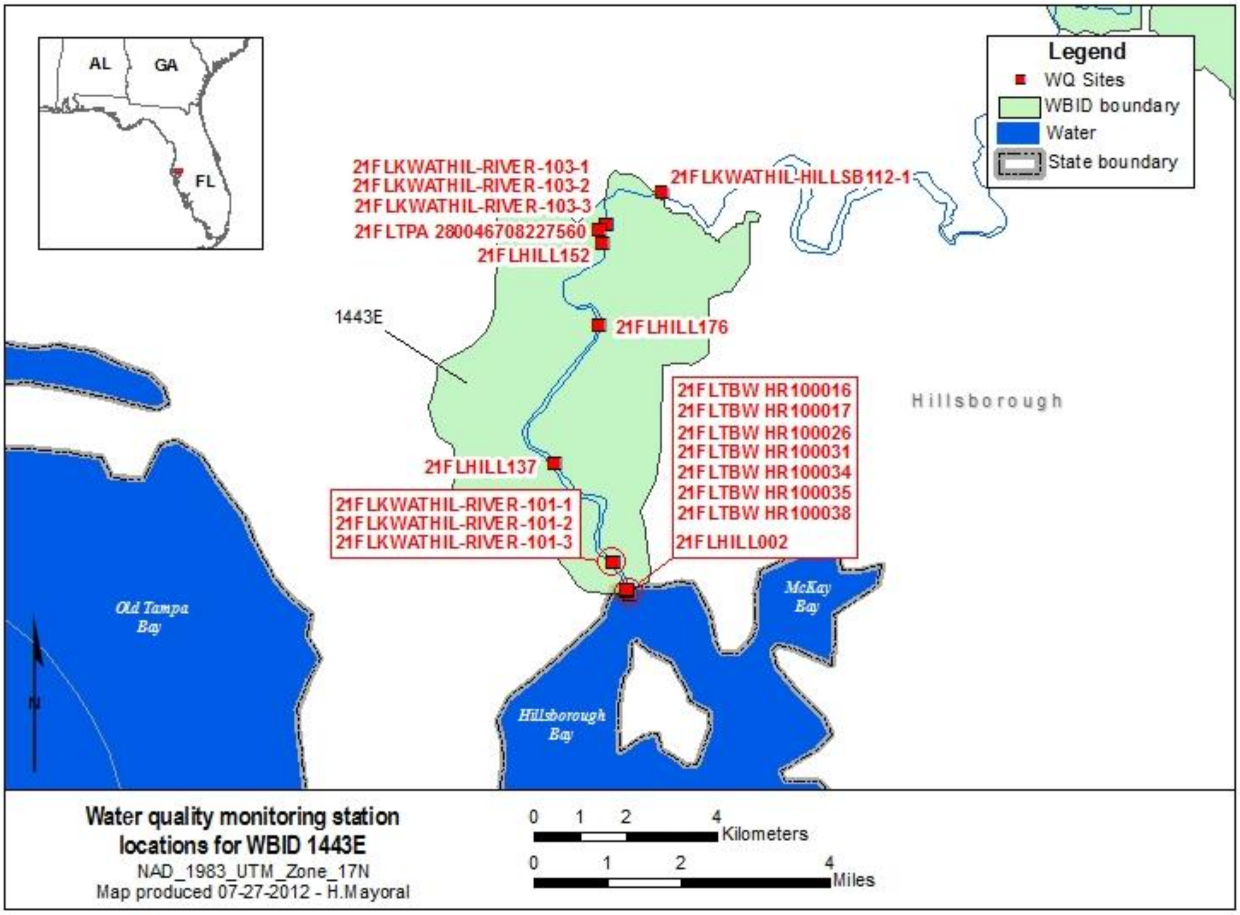


Figure 5.3 Water quality monitoring station locations for impaired WBID 1443E in the Hillsborough River basin

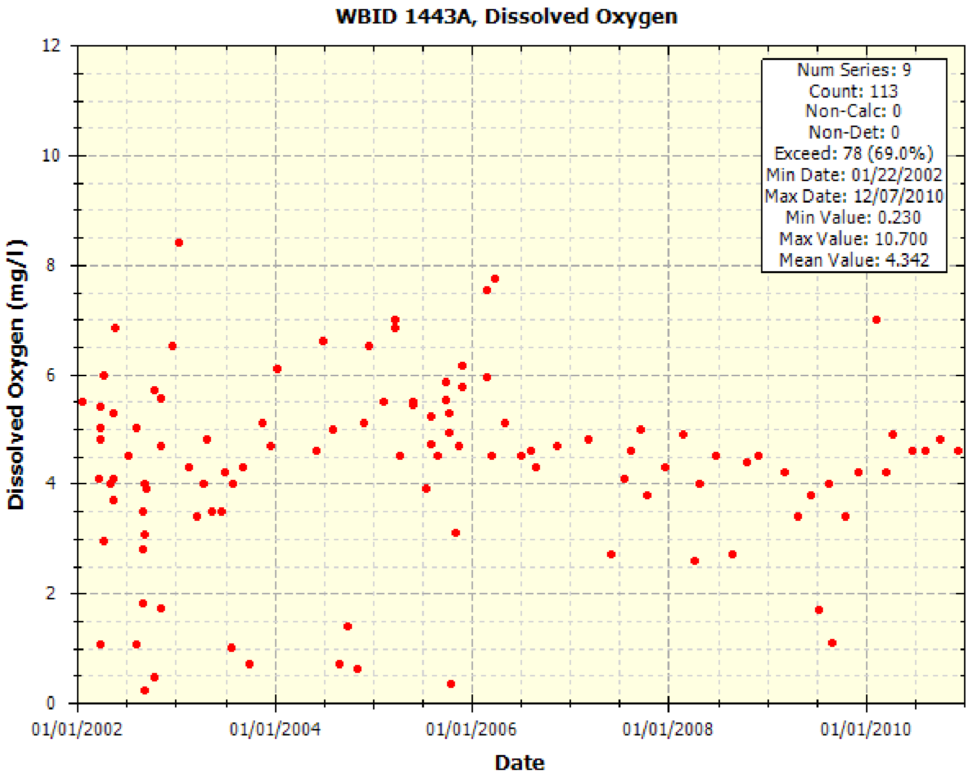


Figure 5.4 Dissolved oxygen concentrations for WBID 1443A

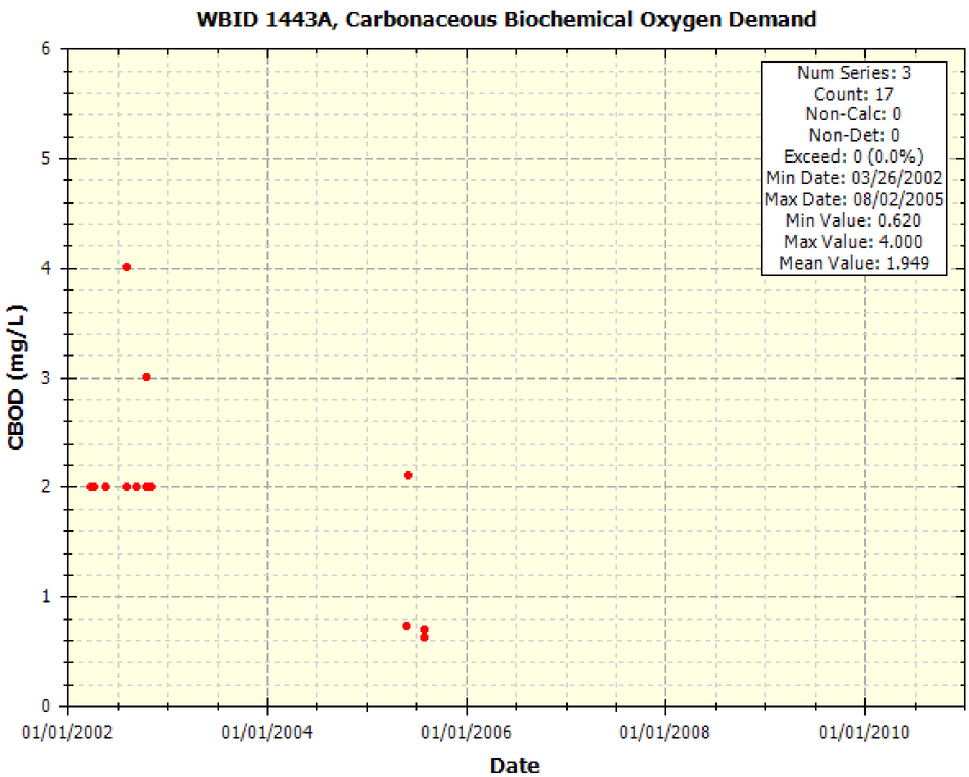


Figure 5.5 Carbonaceous biochemical oxygen demand concentrations for WBID 1443A

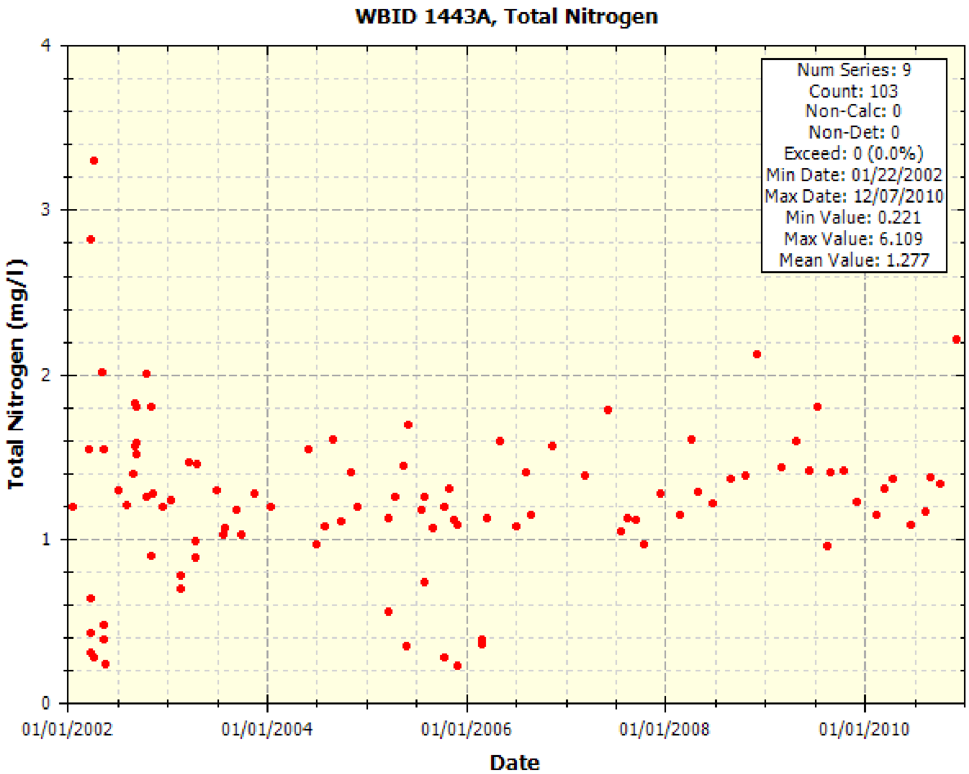


Figure 5.6 Total nitrogen concentrations for WBID 1443A

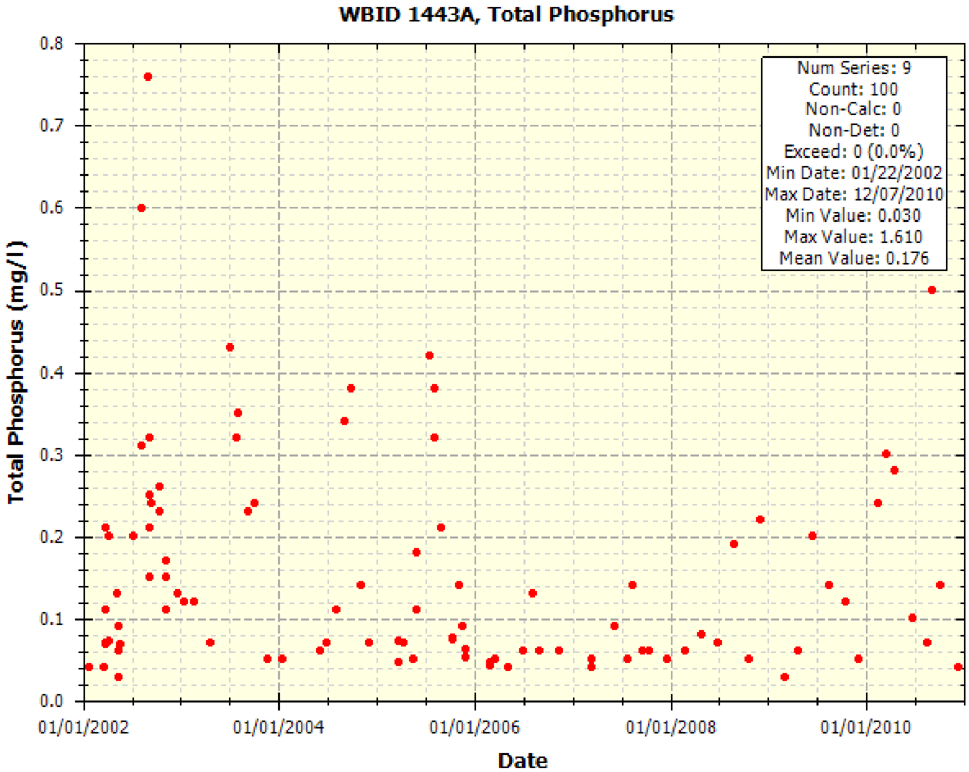


Figure 5.7 Total phosphorus concentrations for WBID 1443A

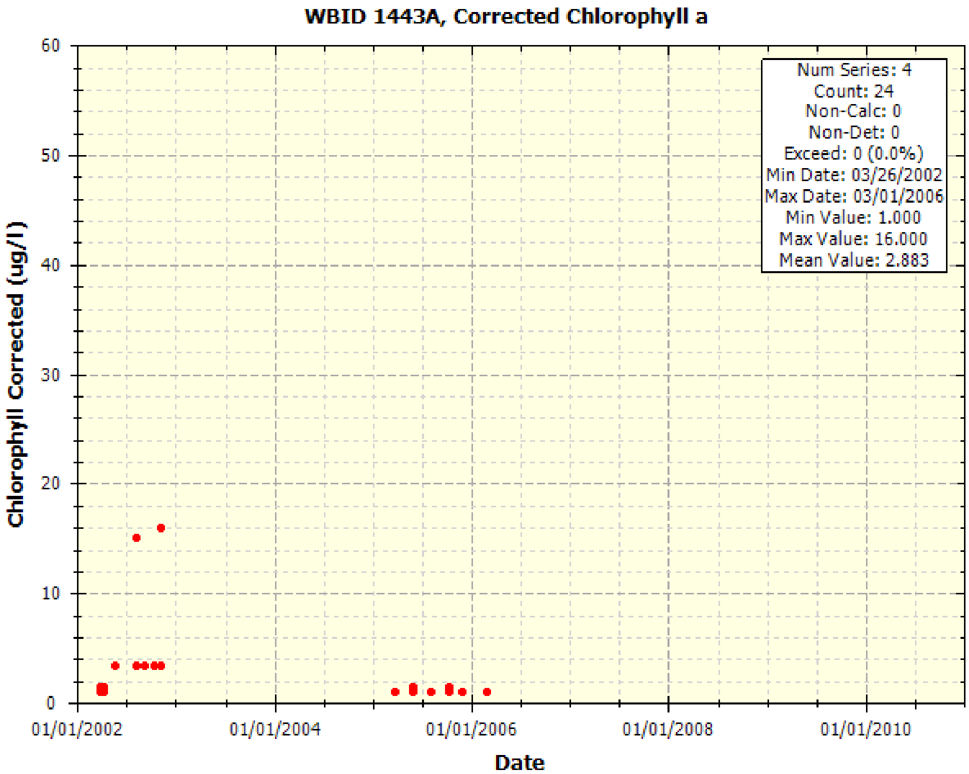


Figure 5.8 Corrected chlorophyll a concentrations for WBID 1443A

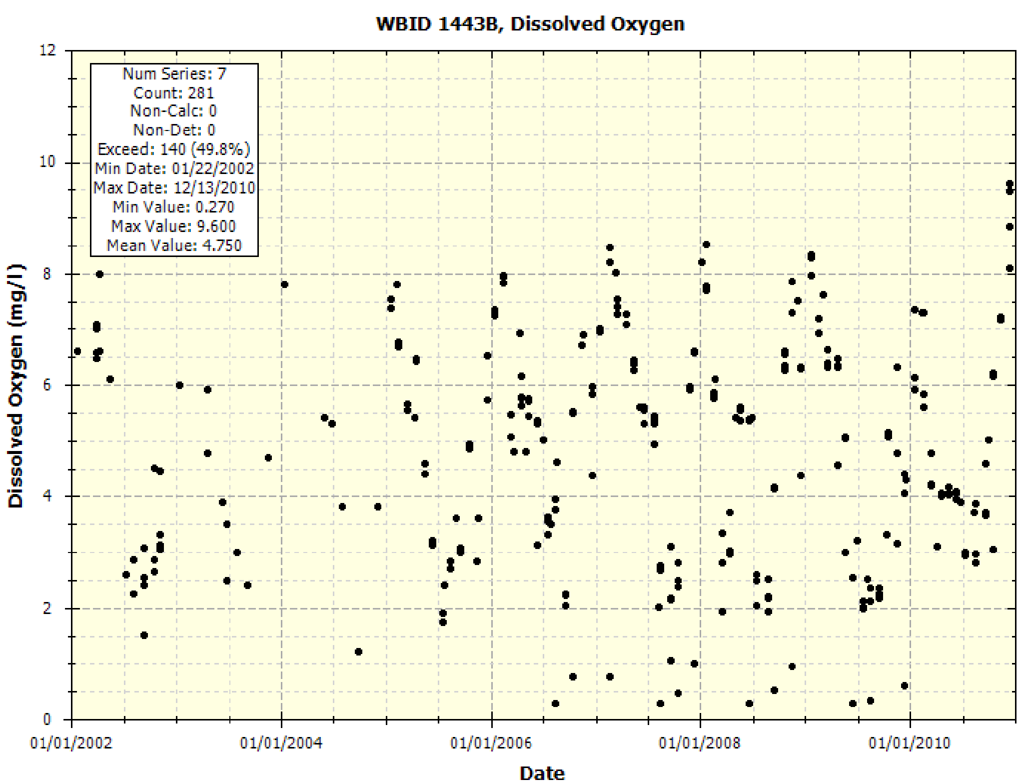


Figure 5.9 Dissolved oxygen concentrations for WBID 1443B

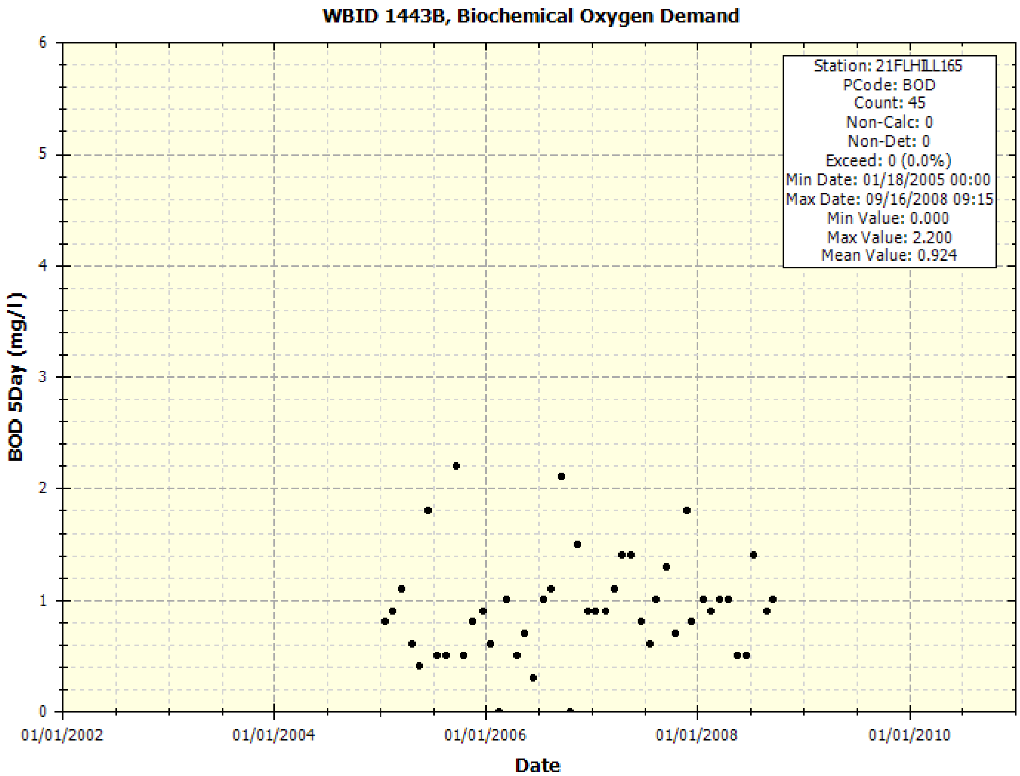


Figure 5.10 Biochemical oxygen demand concentrations for WBID 1443B

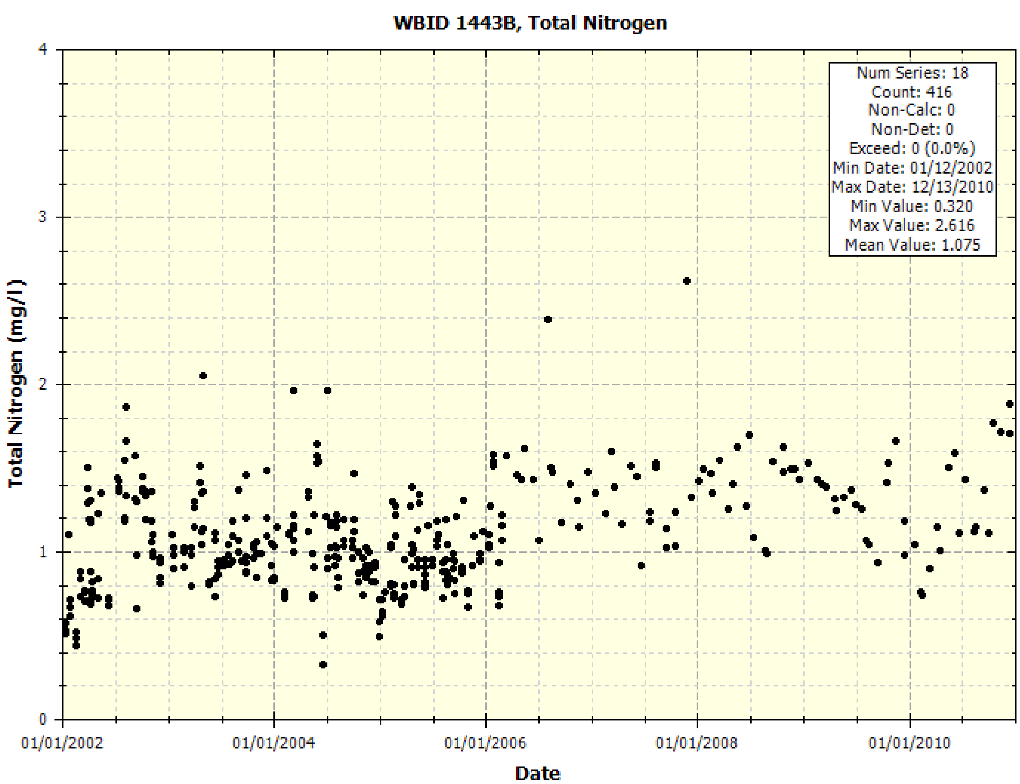


Figure 5.11 Total nitrogen concentrations for WBID 1443B

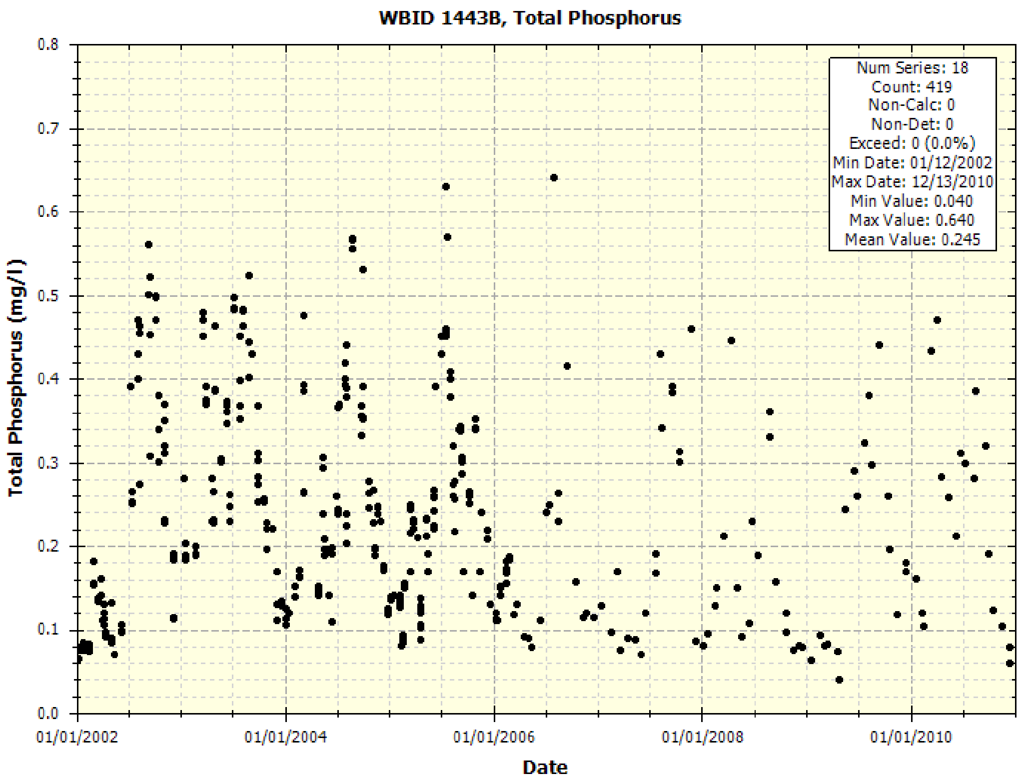


Figure 5.12 Total phosphorus concentrations for WBID 1443B

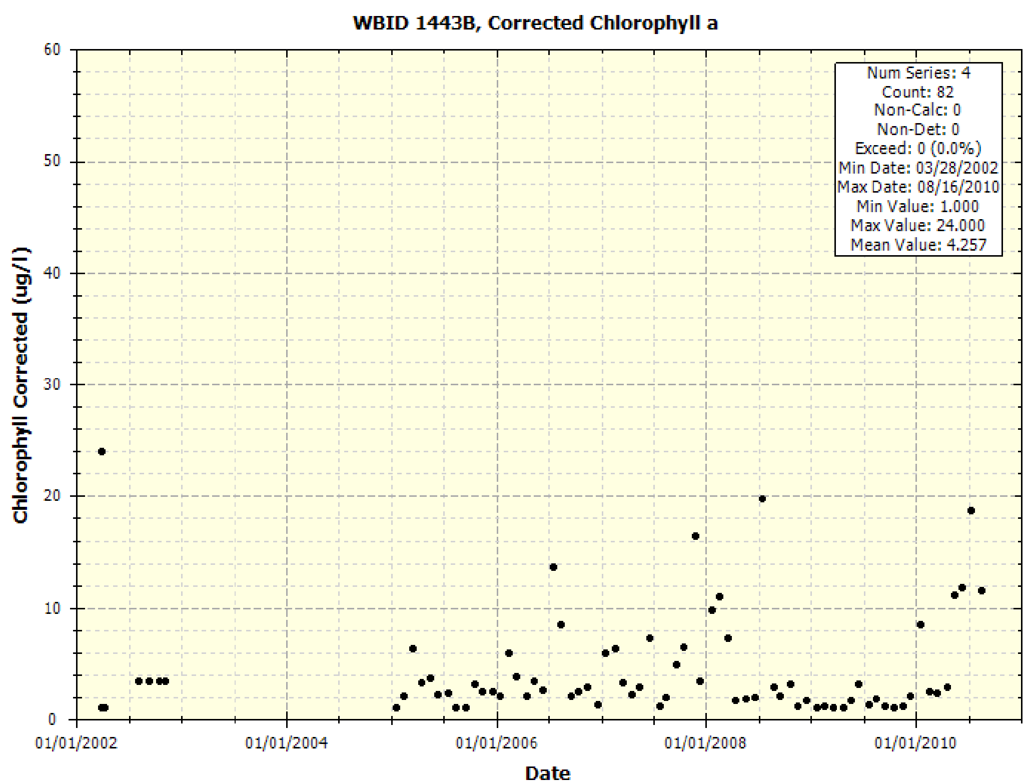


Figure 5.13 Corrected chlorophyll a concentrations for WBID 1443B

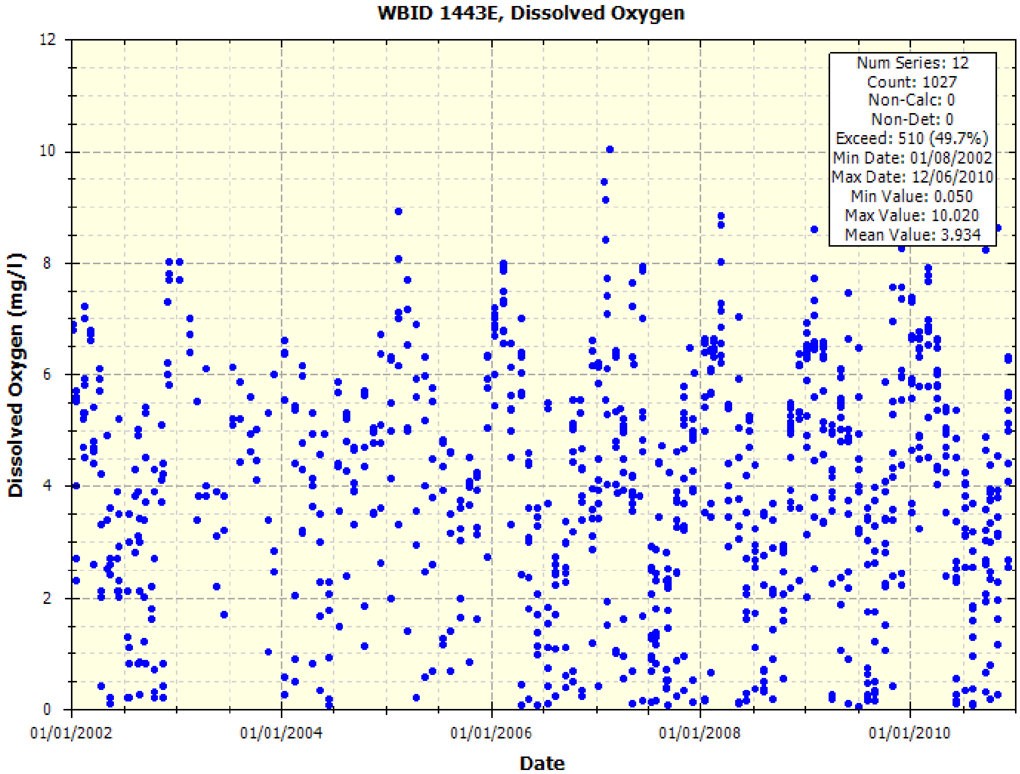


Figure 5.14 Dissolved oxygen concentrations for WBID 1443E

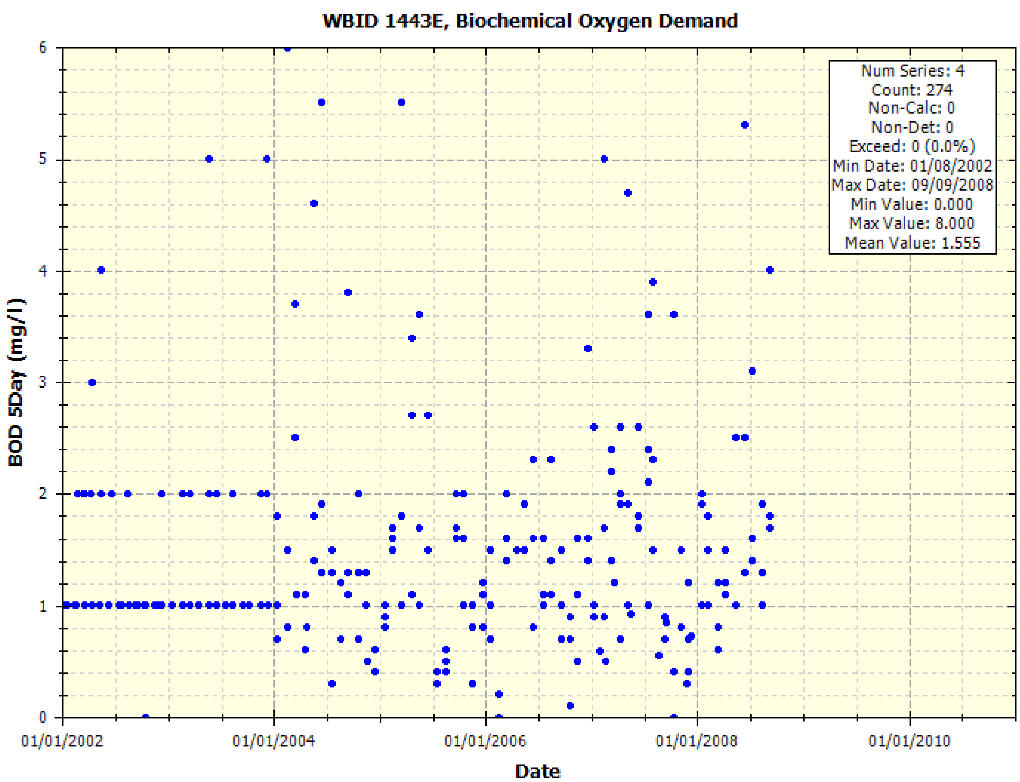


Figure 5.15 Biochemical oxygen demand concentrations for WBID 1443E

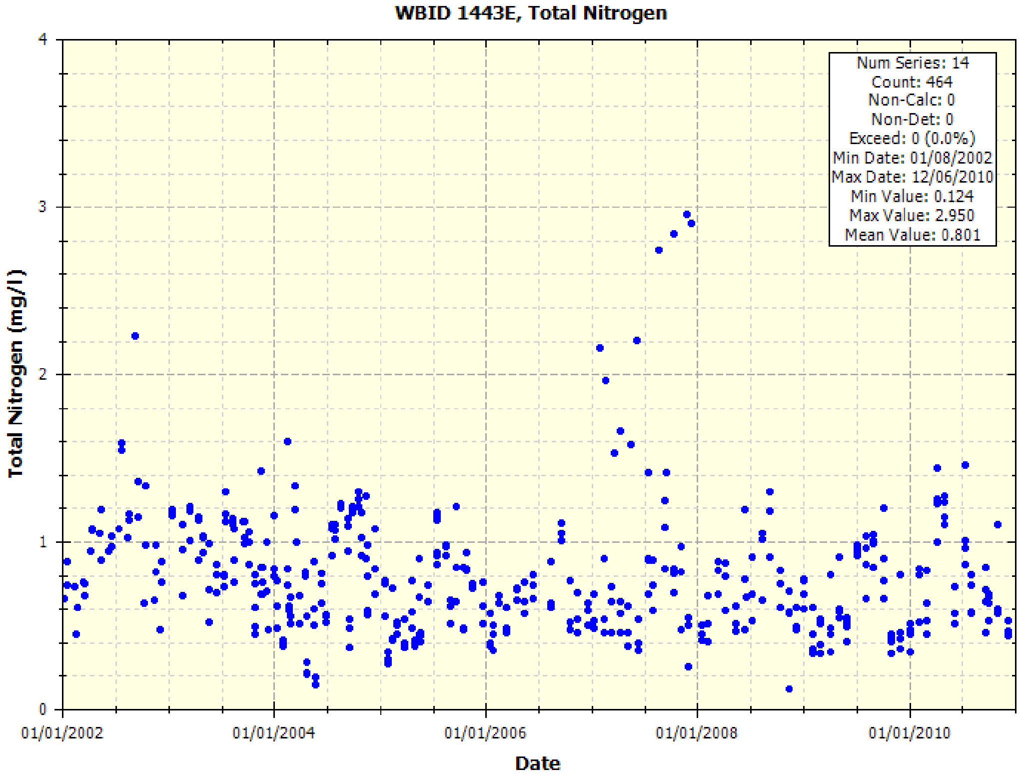


Figure 5.16 Total nitrogen concentrations for WBID 1443E

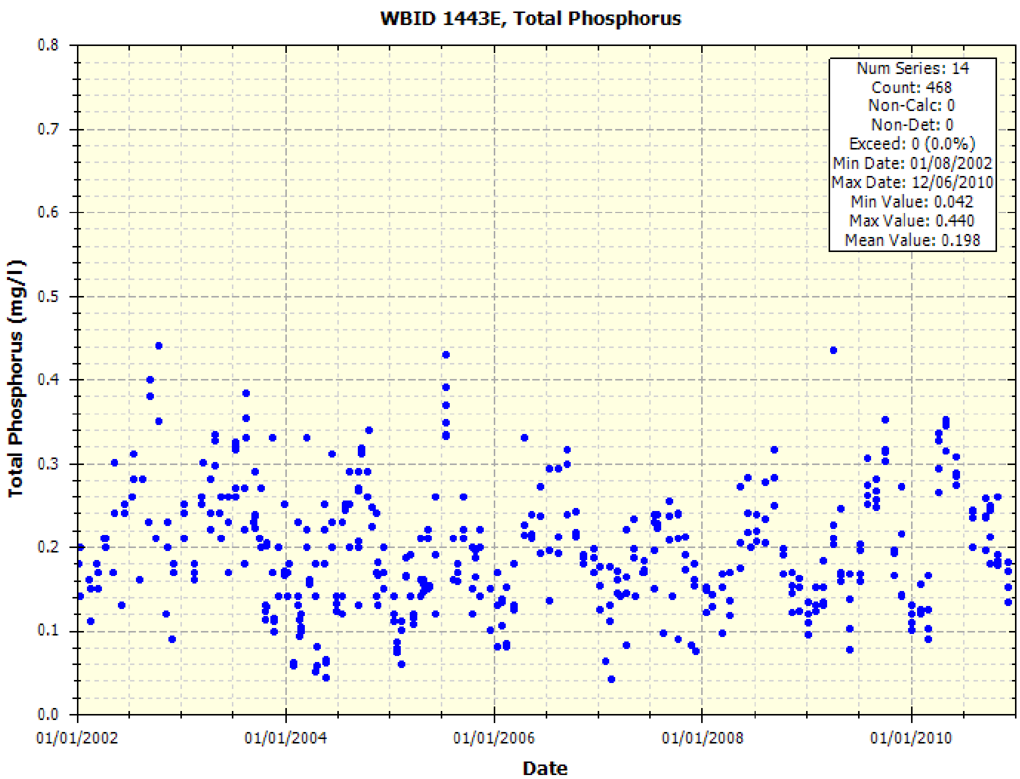


Figure 5.17 Total phosphorus concentrations for WBID 1443E

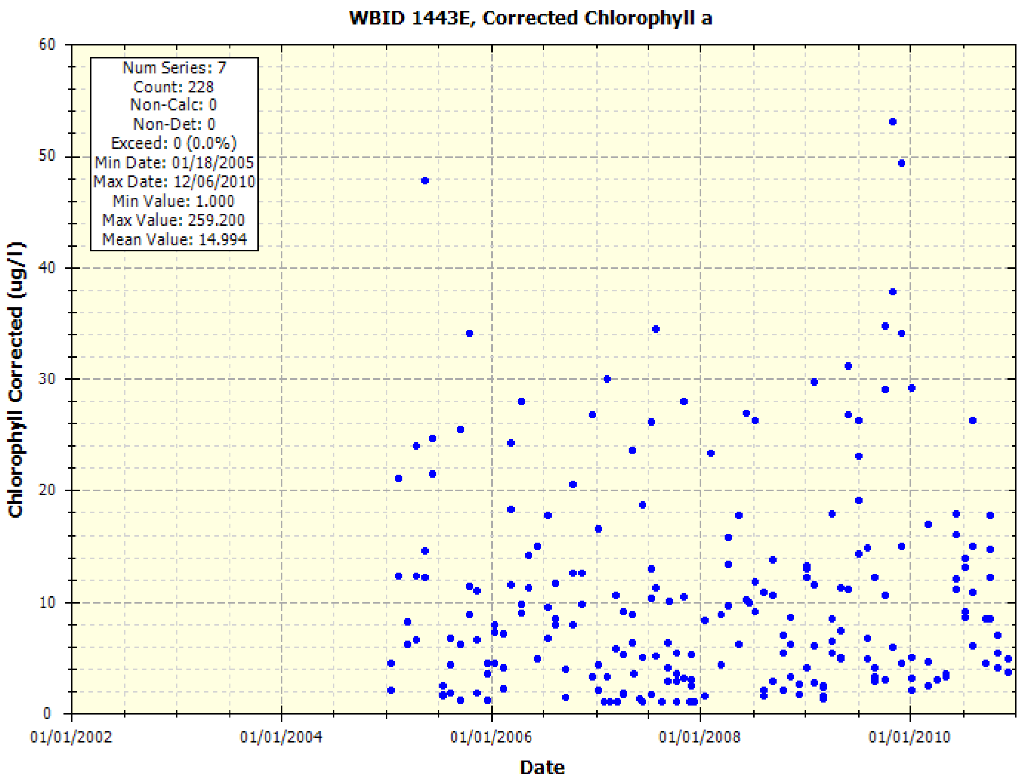


Figure 5.18 Corrected chlorophyll a concentrations for WBID 1443E

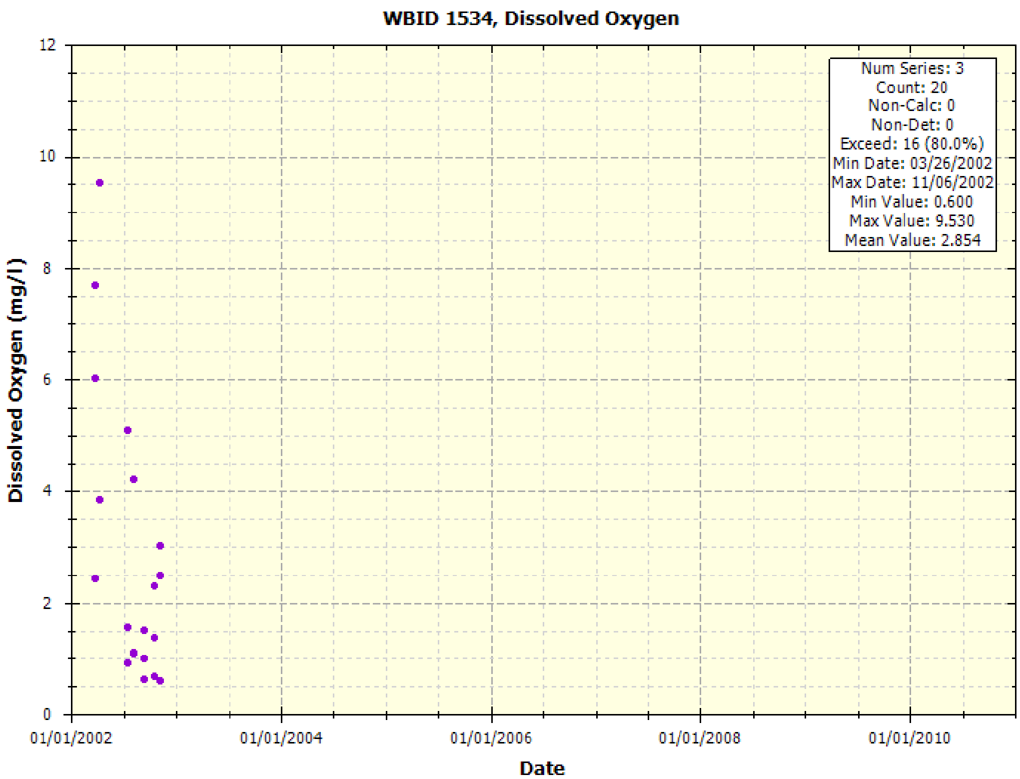


Figure 5.19 Dissolved oxygen concentrations for WBID 1534

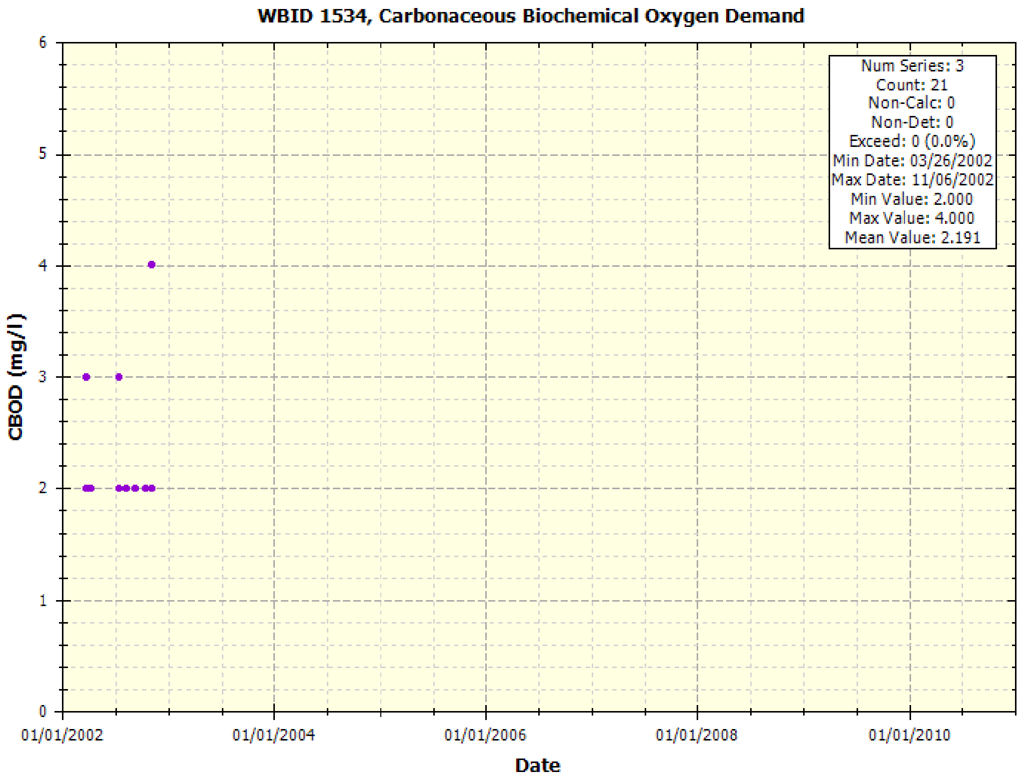


Figure 5.20 Carbonaceous biochemical oxygen demand concentrations for WBID 1534

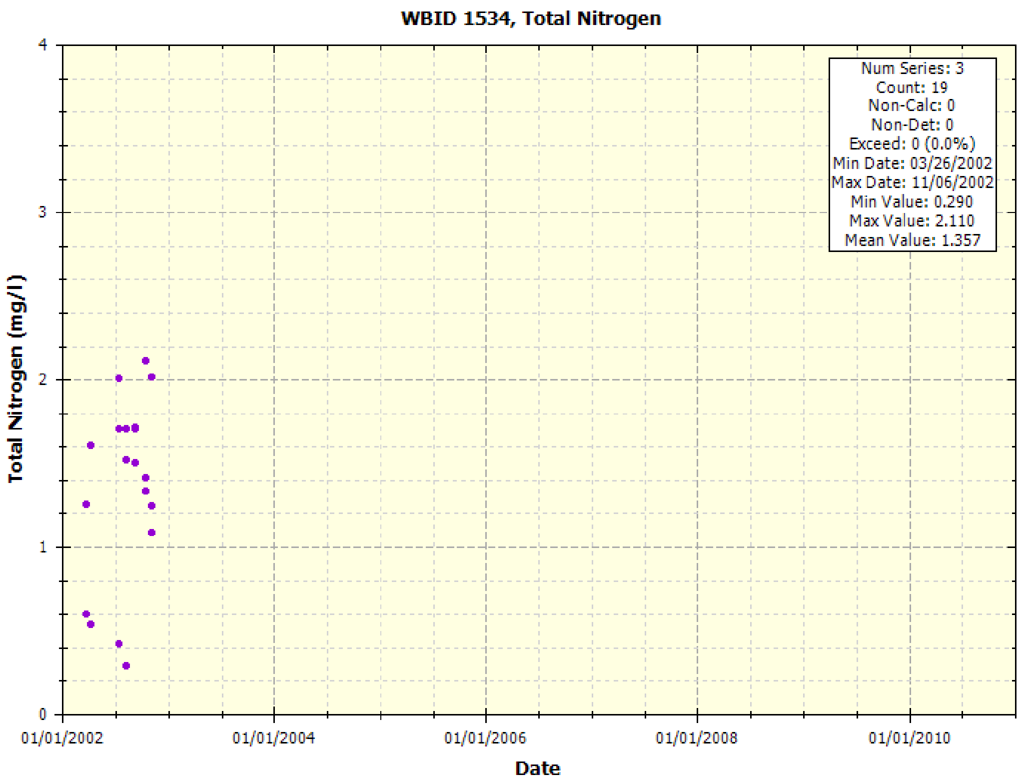


Figure 5.21 Total nitrogen concentrations for WBID 1534

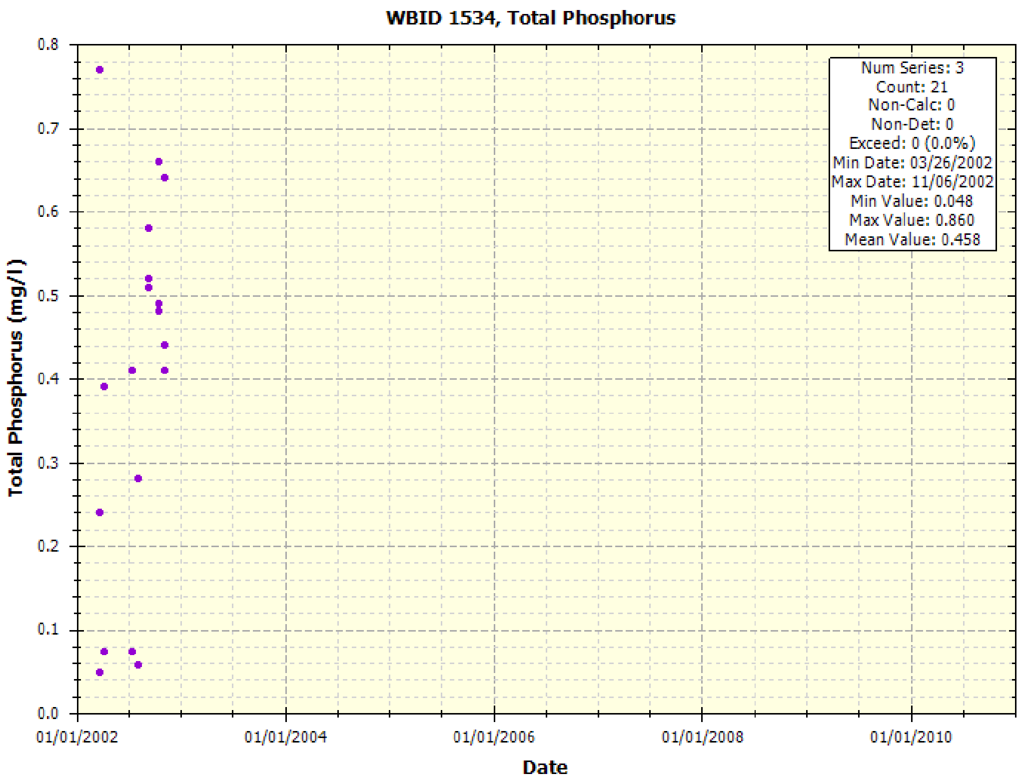


Figure 5.22 Total phosphorus concentrations for WBID 1534

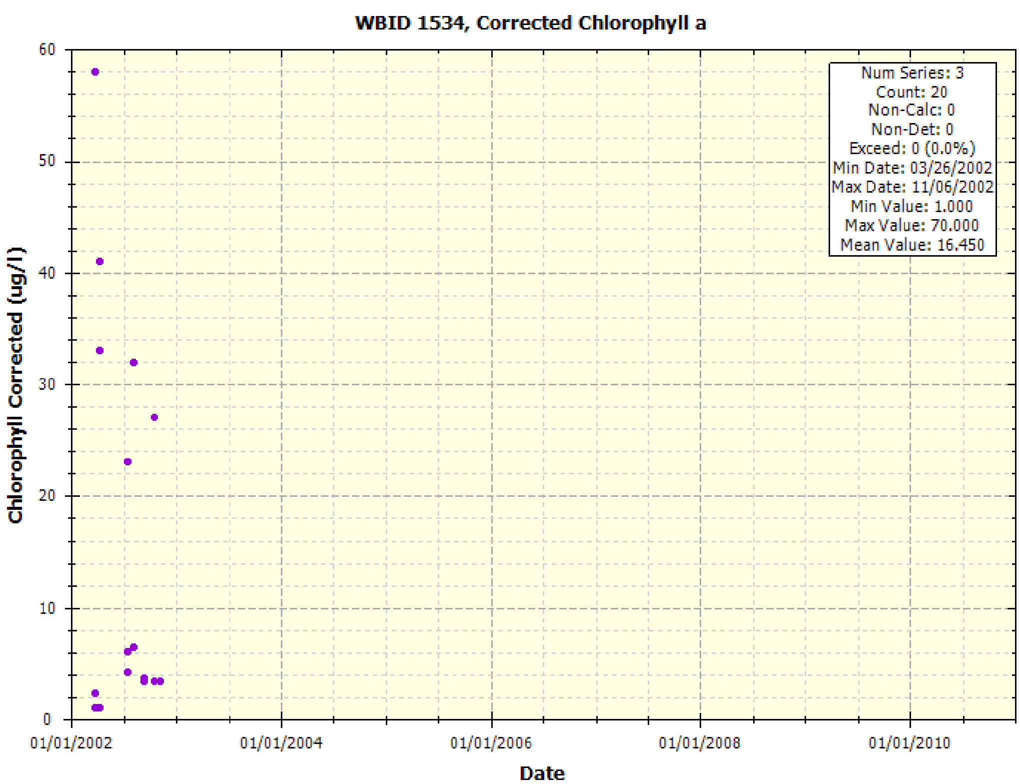


Figure 5.23 Corrected chlorophyll a concentrations for WBID 1534

# 6.0 SOURCE AND LOAD ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. Nutrients can enter surface waters from both point and nonpoint sources.

## *6.1 Point Sources*

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted discharges include continuous discharges such as wastewater treatment facilities as well as some stormwater driven sources such as municipal separate storm sewer systems (MS4s), certain industrial facilities, and construction sites over one acre.

### 6.1.1 Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to wastewater and industrial NPDES-permitted facilities discharging to surface waters within an impaired watershed (Figure 6.1). In WBID 1443E, there are two NPDES-permitted facilities; one belonging to the City of Tampa for the Howard F. Curren Advanced Wastewater Treatment Facility (FL0020940), and the other to the Africa Exhibit in the Lowry Park Zoological Garden (FL0186651). Discharge was recorded as no discharge most months, and was often less than 0.1 MGD. Therefore, it was not included in the model and its WLA was not calculated. The City of Tampa Wastewater Treatment Facility was not included in the WLA calculation because it is a land application and does not drain directly to the Hillsborough River.

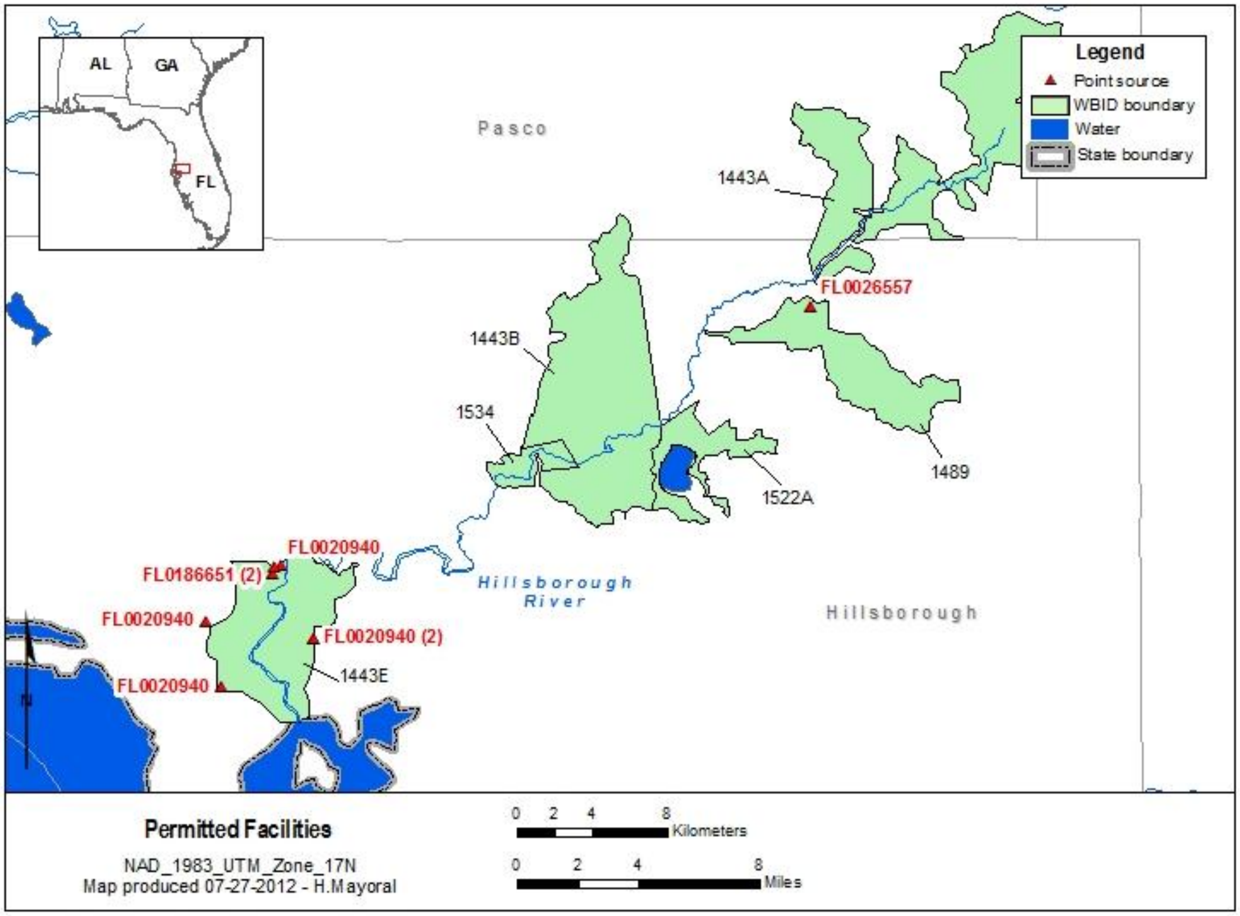


Figure 6.1 Permitted facilities in the impaired WBIDs

### 6.1.2 Stormwater Permitted Facilities/MS4s

MS4s are point sources also regulated by the NPDES program. According to 40 CFR 122.26(b)(8), an MS4 is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

(i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States;

(ii) Designed or used for collecting or conveying storm water;

(iii) Which is not a combined sewer; and

(iv) Which is not part of a Publicly Owned Treatment Works."

MS4s may discharge nutrients and other pollutants to waterbodies in response to storm events. In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES stormwater program to certain "small" MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES stormwater program. Only a select subset of small MS4s, referred to as "regulated small MS4s", requires an NPDES stormwater permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of "urbanized areas" that are designated by NPDES permitting authorities.

In October 2000, USEPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (FS). The three major components of NPDES stormwater regulations are:

- MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.
- Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.
- Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

Stormwater discharges conveyed through the storm sewer system covered by the permit are subject to the WLA of the TMDL, where appropriate. Any newly designated MS4s will also be required to achieve the percent reduction allocation presented in this TMDL. The MS4 permits pertaining to each of the impaired WBIDs are listed in Table 6.1.

Table 6.1 MS4 Permits in the impaired WBIDs

| WBID | Segment Name | Phase | Facility Number | Affiliate |
|---|---|---|---|---|
| 1443A | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I C | FLS000015* | Polk County |
| | | I C | FLS000032* | Pasco County |
| | | I | FLS000032 | City of Zephyrhills |
| 1443B | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I C | FLS000032* | Pasco County |
| 1443E | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I | FLS000008 | City of Tampa |
| 1534 | Cow House Creek | I C | FLS000006* | Hillsborough County |
| | | I | FLS000009 | City of Temple Terrace |

*FDOT

## *6.2 Nonpoint Sources*

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For nutrients, these sources include runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. Nonpoint source pollution generally involves a buildup of pollutants on the land surface that wash off during rain events and as such, represent contributions from diffuse sources, rather than from a defined outlet. Potential nonpoint sources are commonly identified, and their loads estimated, based on land cover data. Most methods calculate nonpoint source loadings as the product of the water quality concentration and runoff water volume associated with certain land use practices. The mean concentration of pollutants in the runoff from a storm event is known as the event mean concentration. Figure 3.1 provides a map of the land use, while Table 3.1 lists the land use distribution within each of the WBIDs.

The following sections are organized by land use. Each section provides a description of the land use, the typical sources of nutrient loading (if applicable), and typical total nitrogen and total phosphorus event mean concentrations.

### 6.2.1 Urban Areas

Urban areas include land uses such as residential, industrial, extractive and commercial. Land uses in this category typically have somewhat high total nitrogen event mean concentrations and average total phosphorus event mean concentrations. Nutrient loading from MS4 and non-MS4 urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 FS, was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water." [FAC 62-40-.432(2)(c)]

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of nonpoint source pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimization of impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Urban, residential, and commercial developments are often a significant nonpoint source of nutrients and oxygen-demanding substances. Developed land use accounts for 25-50 percent of the total land use within each of the WBIDs.

### *Onsite Sewage Treatment and Disposal Systems (Septic Tanks)*

As stated above, leaking septic tanks or onsite sewage treatment and disposal systems (OSTDs) can contribute to nutrient loading in urban areas. Water from OSTDs is typically released to the ground through on-site, subsurface drain fields or boreholes that allow the water from the tank to percolate (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD receives natural biological treatment in the soil and is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 6.2 summarizes the cumulative number of septic systems installed in Hillsborough, Pasco and Polk Counties since the 1970 census and the total number of repair permits issued for the ten years between 1999-2000 and 2009-2010 (FDOH 2009). The data do not reflect septic tanks removed from service. Leaking septic systems could be a relevant source of organic and nutrient loading in the watershed.

Table 6.2 County estimates of Septic Tanks and Repair Permits

| County | Number of Septic Tanks (1970-2008) | Number of Repair Permits Issued (2000-2010) |
|---|---|---|
| Hillsborough | 107,198 | 15,437 |

| | | |
|---|---|---|
| Pasco | 70,594 | 11,601 |
| Polk | 118,392 | 20,510 |

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

### 6.2.2 Pastures and Row Crops

Pastures include cropland and improved and unimproved pasturelands, such as non-tilled grasses woodland pastures, feeding operations, nurseries and vineyards; as well as specialty farms. Crop lands include row and field crops, citrus groves, fruit orchards, and other groves including sugarcane groves. Agricultural activities, including runoff of fertilizers or animal wastes from pasture and cropland and direct animal access to streams, can generate nutrient loading to streams. The highest total nitrogen and total phosphorus event mean concentrations are associated with agricultural land uses.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA NASS 2007). According to the 2007 Census of Agriculture (Table 6.3), the amount of acreage in farms being fertilized with commercial fertilizer, lime and soil conditioners was greater than 164,000 acres over 1,856 farms in Polk County; while farms fertilizing with manure totaled 5,239 acres. Livestock counts of cattle and pigs in Hillsborough, Pasco, and Polk Counties are provided in Table 6.4. Due to agricultural census data being collected at the county level, the extent to which these values pertain to agricultural fields within the impaired watershed is not specified.

Pastures account for 15-33 percent of the total land use contributing to each of the WBIDs, and therefore could potentially be a source of excessive nutrients within those waterbodies.

Table 6.3 Agricultural Census Data for Commercially and manure fertilized farms in Hillsborough, Pasco, and Polk Counties, Florida

| County | Commercial | | Manure | |
|---|---|---|---|---|
| | Number of Farms | Number of Acres | Number of Farms | Number of Acres |
| Hillsborough | 1,332 | 55,993 | 214 | 2,508 |
| Pasco | 578 | 31,641 | 96 | 2,463 |
| Polk | 1,856 | 164,500 | 73 | 5,239 |

Table 6.4 Agricultural Census Data for Livestock in Hillsborough, Pasco, and Polk Counties, Florida

| County | Livestock | Number of Farms | Number of Animals |
|---|---|---|---|
| Hillsborough | Cattles and Calves | 1,475 | 1,475 |
| | Hogs and Pigs | 83 | D |
| Pasco | Cattles and Calves | 651 | 33,424 |
| | Hogs and Pigs | 28 | 210 |
| Pinellas | Cattles and Calves | 14 | 130 |

| County | Livestock | Number of Farms | Number of Animals |
|---|---|---|---|
| | Hogs and Pigs | 2 | - |

D = data withheld to avoid disclosing data for individual farms

### 6.2.3 Clear cut/Sparse

The clear cut/sparse land use classification includes recent clear cuts, areas of sparse vegetation or herbaceous dry prairie, shrub and brushland, other early successional areas, and mixed rangeland. Event mean concentrations for clear cut/sparse can be relatively low for total nitrogen and total phosphorus. Clear cut/sparse land use accounts for 0 and 9 percent of the total land use contributing to each of the WBIDs. WBID 1534 has no clear cut/sparse land uses contributing to the area, while WBID 1443A has 9 percent of the total contributing land use consisting of clear cut/sparse.

### 6.2.4 Forests

Upland forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Wildlife, located within forested areas, deposit their feces onto land surfaces where it can be transported to nearby streams during storm events. Generally, the pollutant load from wildlife is assumed to represent background concentrations. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus. Combined forests account for 6-17 percent of the total contributing land use to each of the WBIDs.

### 6.2.5 Water and Wetlands

Water and Wetlands often have very low nutrient loadings, although decaying organic matter in wetlands can contribute to high organic nutrient concentrations. Open water accounts for less than 3 percent of the total land use contributing to each of the WBIDs.

### 6.2.6 Quarries/Strip mines

Land use classification includes quarries, strip mines, exposed rock and soil, fill areas, reclaimed lands, and holding ponds. Event mean concentrations for some barren lands tend to be higher in total nitrogen. Quarries/strip mines account for less than 3 percent of the total land use contributing to each of the WBIDs.

## 7.0 ANALYTICAL APPROACH

In the development of a TMDL there needs to be a method for relating current loadings to the observed water quality problem. This relationship could be: statistical (regression for a cause and effect relationship), empirical (based on observations not necessarily from the waterbody in question) or mechanistic (physically and/or stochastically based) that inherently relate cause and effect using physical and biological relationships.

Mechanistic models were used in the development of the Hillsborough River TMDL to relate the physical and biological relationships. A dynamic watershed model was used to predict the quantity of water and pollutants associated with runoff from rain events. The watershed model was linked to a hydrodynamic model that simulated tidal influences in the river. Both models were linked to a water quality simulation model that integrated the loadings and flow from the watershed model with flow from the hydrodynamic model to predict the water quality in the receiving waterbodies.

The period of simulation that was considered in the development of this TMDL is January 1, 2002 to December 31, 2009. The models were used to predict time series for BOD, TN, TP, and DO. The models were calibrated to current conditions and were then used to predict improvements in water quality as a function of reductions in loadings.

## *7.1 Mechanistic Models*

### 7.1.1 Loading Simulation Program C++ (LSPC)

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality overland as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by USEPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the USEPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the USEPA TMDL Modeling Toolbox. LSPC was used to simulate runoff (flow, biological oxygen demand, total nitrogen, total phosphorus and dissolved oxygen) from the land surface using a daily timestep for current and natural conditions. LSPC provided tributary flows and temperature to the EFDC estuary models and tributary water quality concentrations to WASP7 estuary models.

An LSPC model was utilized to estimate the nutrient loads within and discharged from the Hillsborough River watershed. The LSPC model was used to evaluate dissolved oxygen and nutrient loadings in the impaired freshwater segments of Hillsborough River and provide loadings to the estuarine portion of the river. The LSPC model utilized the data inputs, including land use and weather data, from the larger Tampa Bay Watershed model (USEPA 2012a and USEPA 2012b).

In order to evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of sub-watersheds for each of the models. The sub-watersheds for the Tampa Bay Watershed model were developed using the 12-digit hydrologic unit code (HUC12) watershed data layer and the Geological Survey (USGS) National Hydrograph Dataset (NHD) (Figure 7.1). The sub-watersheds were re-delineated at a smaller scale for the Hillsborough River Watershed model, once again using the NHD catchments as well as the USGS National Elevation Dataset Digital Elevation Model. Contributing watersheds can be found in Table 3.2.

The LSPC model has a representative reach defined for each sub-watershed, and the main channel stem within each sub-watershed was used as the representative reach. The characteristics for each reach include the length and slope of the reach, the channel geometry and the connectivity between the sub-watersheds. Length and slope data for each reach was obtained using the USGS DEM and NHD data.

The attributes supplied for each reach were used to develop a function table (FTABLE) that describes the hydrology of the stream reach by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. The assumption of a fixed depth, area, volume, outflow relationship rules out cases where the flow reverses direction or where one reach influences another upstream of it in a time-dependent way. LSPC does not model the tidal flow in the low-lying estuaries, and therefore the main Tampa Bay Watershed model was calibrated to non-tidally influenced USGS gages. The Hillsborough River Watershed model was linked to the EFDC and WASP models to simulate the areas of the estuary that were tidally influenced.

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loadings. The FDEP Level III Florida Land Use, specifically the Southwest Florida Water Management District (SWFWMD) 2006 dataset, was used to determine the land use representation. The National Landuse Coverage Dataset (NLCD) was used to develop the impervious land use representations.

The SWFWMD coverage utilized a variety of land use classes which were grouped and re-classified into 18 land use categories: beaches/dune/mud, open water, utility swaths, developed open space, developed low intensity, developed medium intensity, developed high intensity, clear-cut/sparse, quarries/strip mines, deciduous forest, evergreen forest, mixed forest, golf courses, pasture, row crop, forested wetland, non-forested wetland (salt/brackish), and non-forested wetland (freshwater). The LSPC model requires division of land uses in each sub-watershed into separate pervious and impervious land units. The NLCD 2006 percent impervious coverage was used to determine the percent impervious area associated with each land use category. Any impervious areas associated with utility swaths, developed open space, and developed low intensity, were grouped together and placed into a new land use category named *low intensity development impervious*. Impervious areas associated with medium intensity development and high intensity development were kept separate and placed into two new categories for *medium intensity development impervious* and *high intensity development impervious*, respectively. Finally, any impervious area not already accounted for in the three developed impervious categories, were grouped together into a fourth new category for all remaining impervious land use.

Soil data for the Florida watersheds was obtained from the Soil Survey Geographic Database (SSURGO). The database was produced and distributed by the Natural Resources Conservation Service (NRCS) - National Cartography and Geospatial Center (NCGC). The SSURGO data was used to determine the total area that each hydrologic soil group covered within each sub-watershed. The sub-watersheds were represented by the hydrologic soil group that had the highest percentage of coverage within the boundaries of the sub-watershed. There were four hydrologic soil groups which varied in their infiltrations rates and water storage capacity.

In the watershed models, nonpoint source loadings and hydrological conditions are dependent on weather conditions. Hourly data from weather stations within the boundaries of, or in close proximity to, the sub-watersheds were applied to the watershed model. A weather data forcing file was generated in ASCII format (*.air) for each meteorological station used in the hydrological evaluations in LSPC. Each meteorological station file contained atmospheric data used in modeling the hydrological processes. These data included precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data are used directly, or calculated from the observed data. The Tampa Bay Watershed model weather stations contained data through 2009.

The hydrodynamic calibration parameters from the larger Tampa Bay Watershed model were used to populate the Hillsborough River watershed model. The Tampa Bay Watershed model was calibrated to continuous flow USGS gages (Figure 7.2 and Figure 7.11). Additionally, the water quality parameters from the larger Tampa Bay Watershed model were used to populate the Hillsborough River Watershed model. The Tampa Bay Watershed model was calibrated to several water quality stations whose data was taken from IWR38. The Hillsborough River watershed was calibrated to water quality data from IWR44. LSPC water quality calibration results are presented in Figure 7.12 through Figure 7.19.

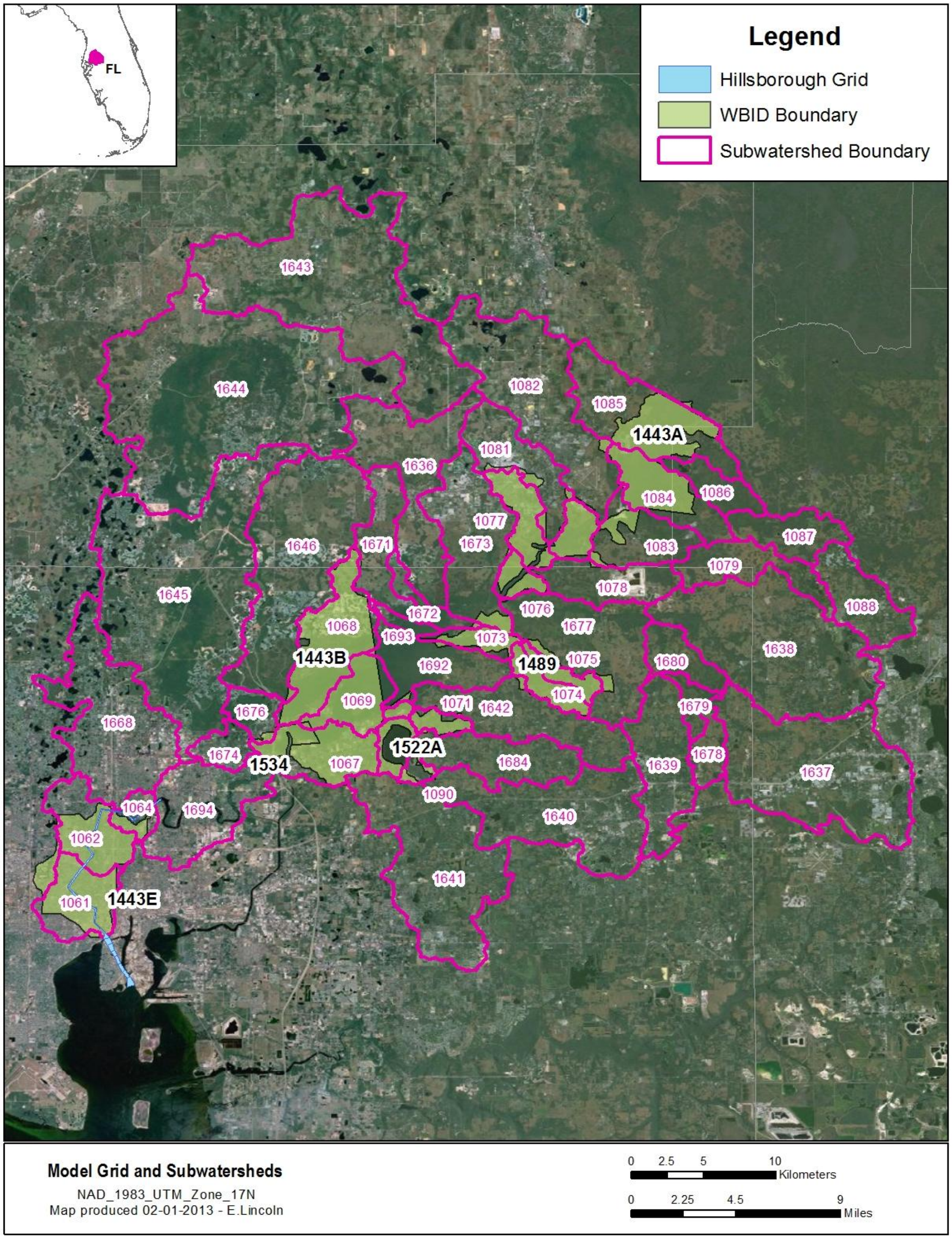


Figure 7.1 LSPC subwatershed boundaries and impaired WBIDs in the Hillsborough River

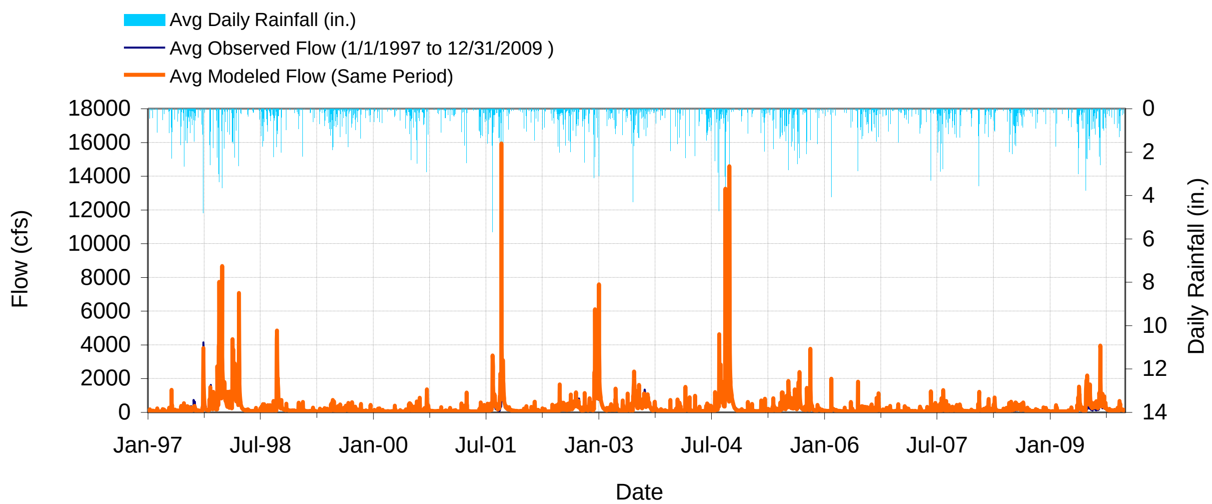


Figure 7.2 Mean daily flow: Model Outlet 1673 vs. USGS 02303000 Hillsborough River near Zephyrhills, FL.

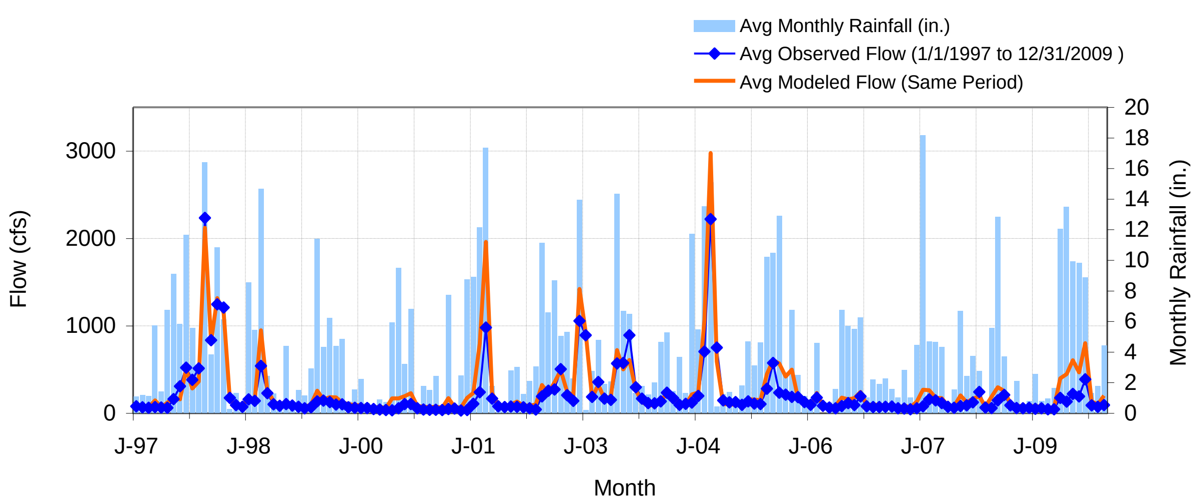


Figure 7.3 Mean monthly flow: Model Outlet 1673 vs. USGS 02303000 Hillsborough River near Zephyrhills, FL.

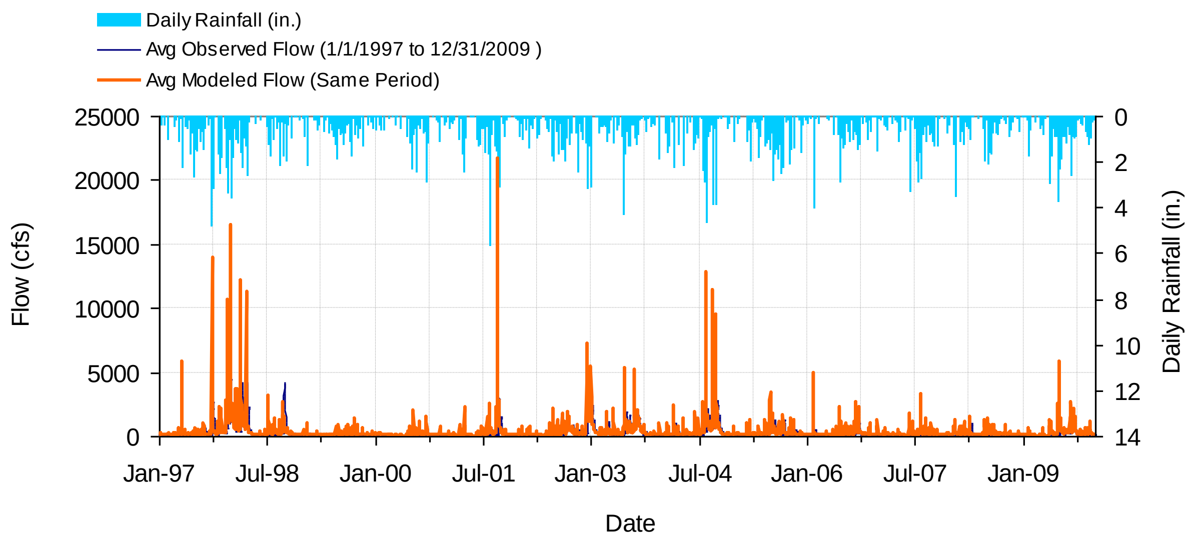


Figure 7.4 Mean daily flow: Model Outlet 1069 vs. USGS 02303330 Hillsborough River at Morris Br Near Thonotosassa FL

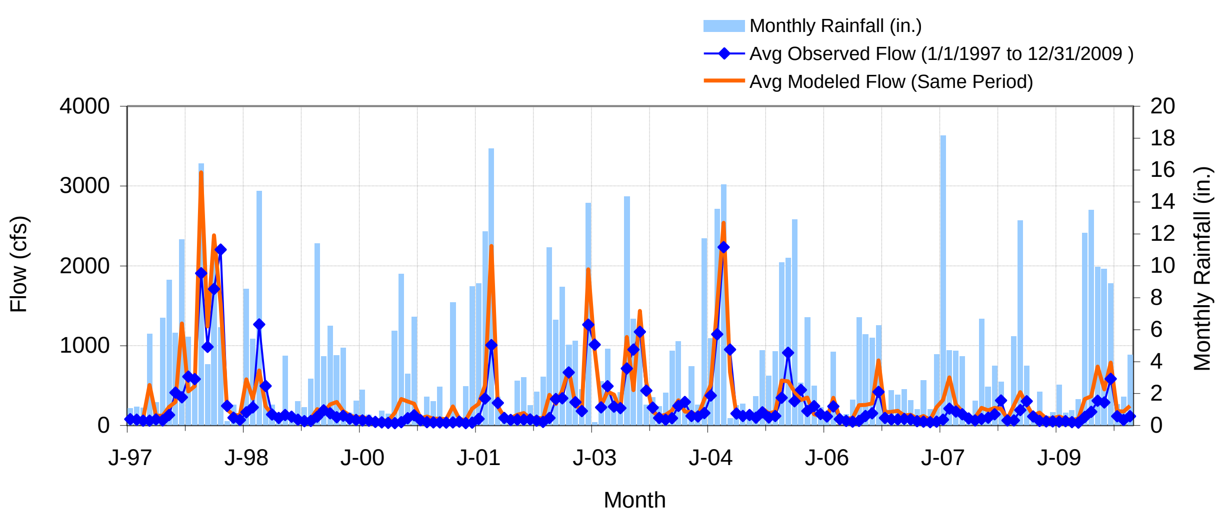


Figure 7.5 Mean monthly flow: Model Outlet 1069 vs. USGS 02303330 Hillsborough River at Morris Br Near Thonotosassa FL

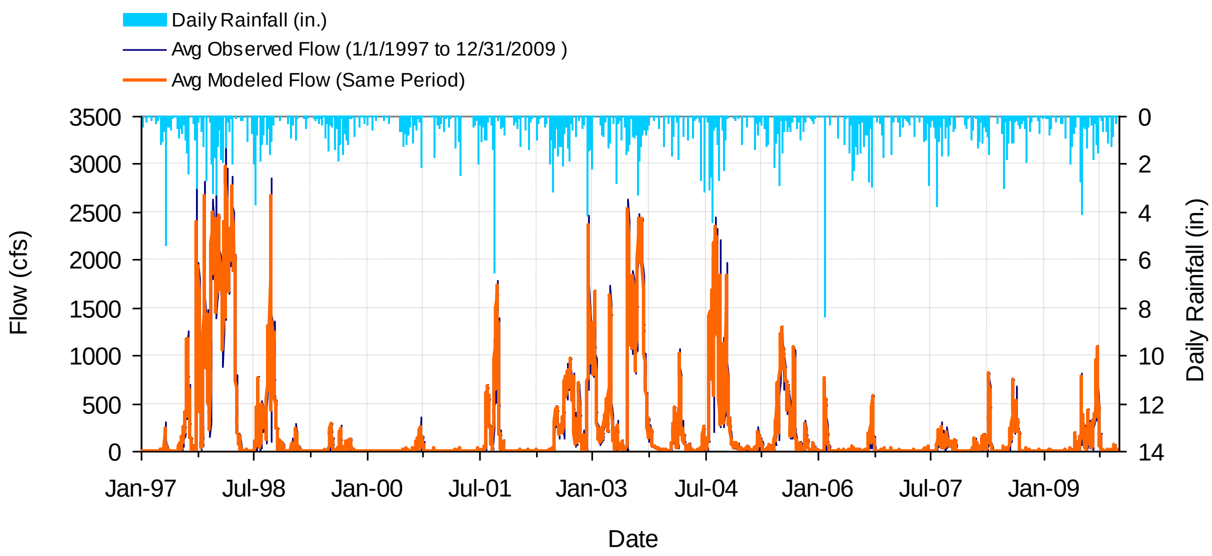


Figure 7.6 Mean daily flow: Model Outlet 160047 vs. USGS 02304500 Hillsborough River near Tampa, FL (USGS No date)

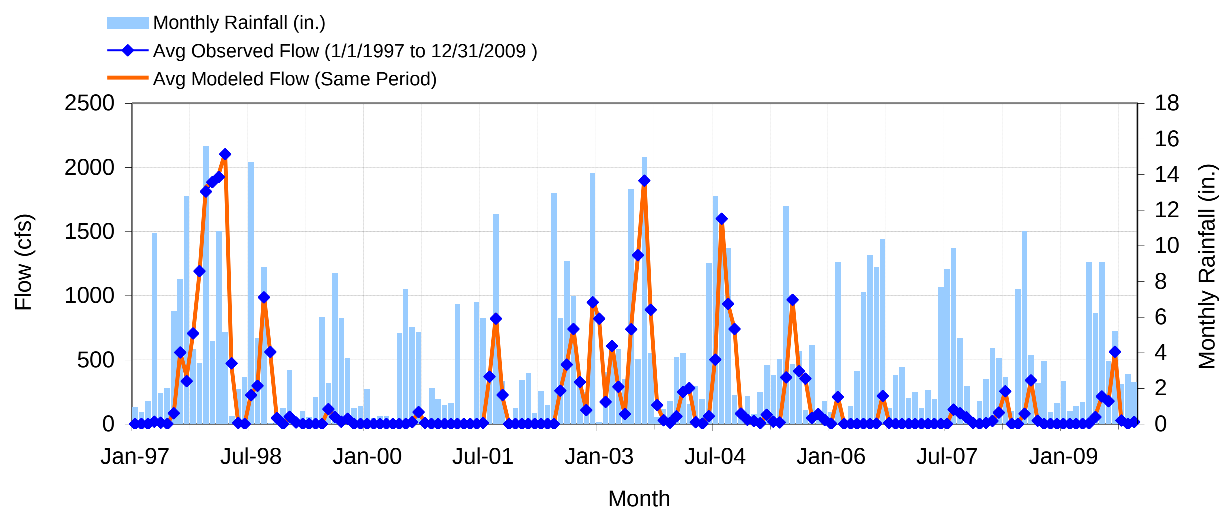


Figure 7.7 Mean monthly flow: Model Outlet 160047 vs. USGS 02304500 Hillsborough River near Tampa, FL (USGS No date)

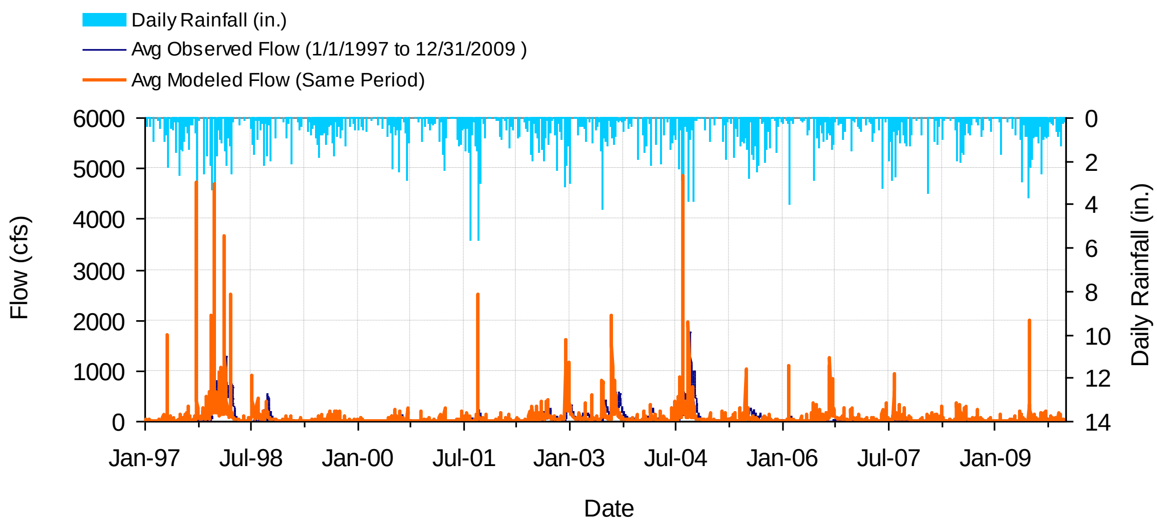


Figure 7.8 Mean daily flow: Model Outlet 1069 vs. USGS 02303420 Cypress Creek at Worthington Gardens, Florida

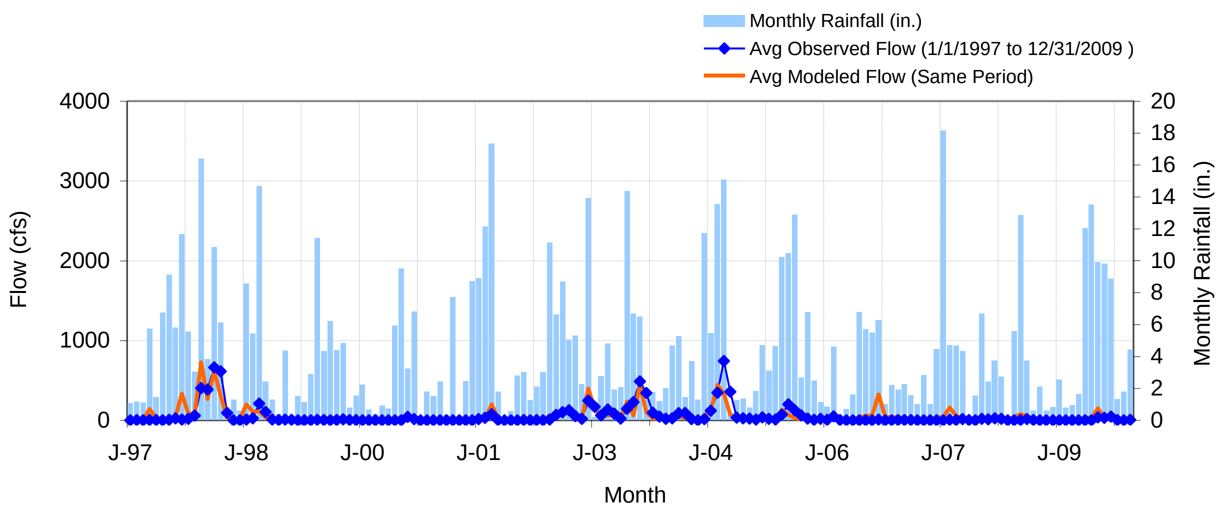


Figure 7.9 Mean monthly flow: Model Outlet 1069 vs. USGS 02303420 Cypress Creek at Worthington Gardens, Florida

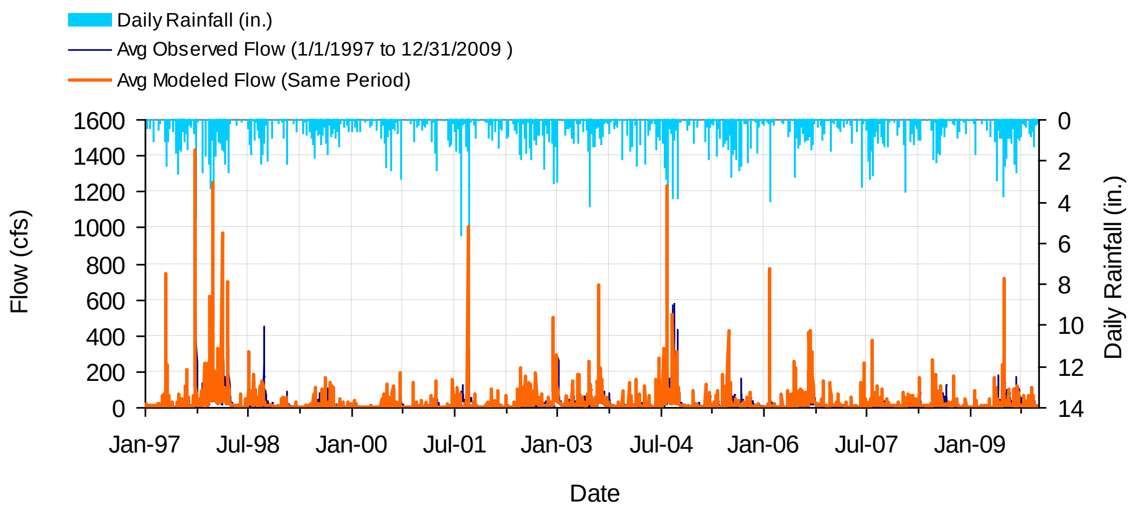


Figure 7.10 Mean daily flow: Model Outlet 1069 vs. USGS 02303205 Baker Creek at McIntosh Road near Antioch, Florida

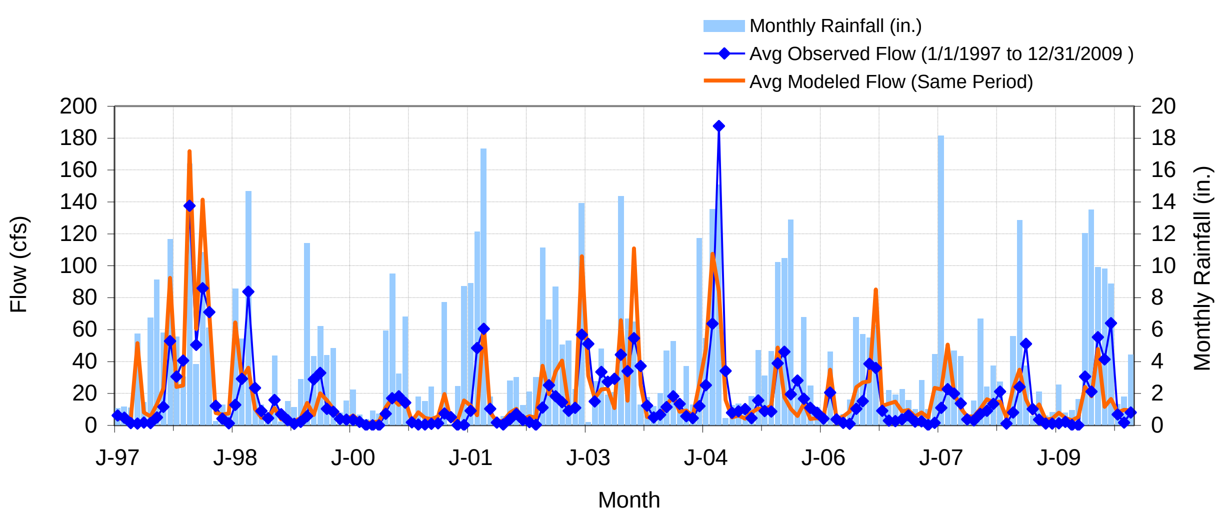


Figure 7.11 Mean monthly flow: Model Outlet 1069 vs. USGS 02303205 Baker Creek at McIntosh Road near Antioch, Florida

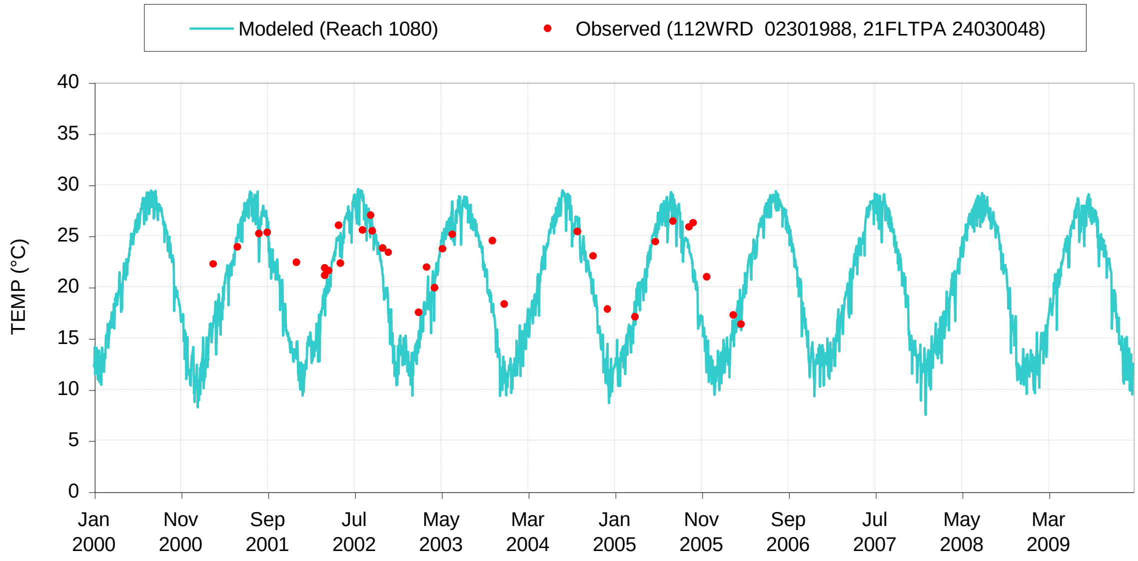


Figure 7.12 Modeled vs. Observed TEMP (°C) at 112WRD 02301988 and 21FLTPA 24030048 in WBID 1443A

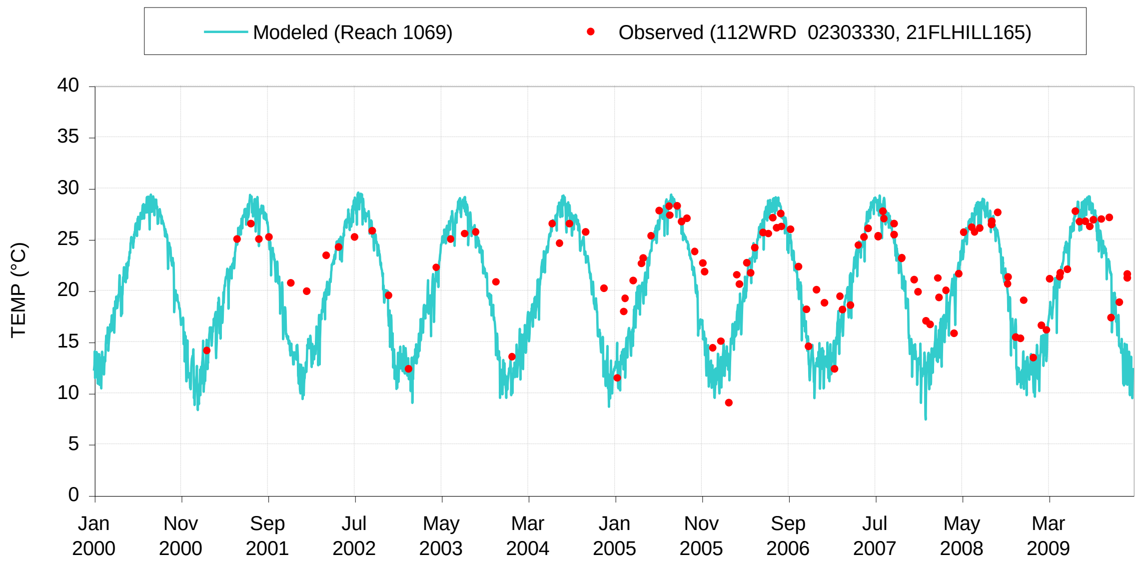


Figure 7.13 Modeled vs. Observed TEMP (°C) at 112WRD 02303330 and 21FLHILL165 in 1443B

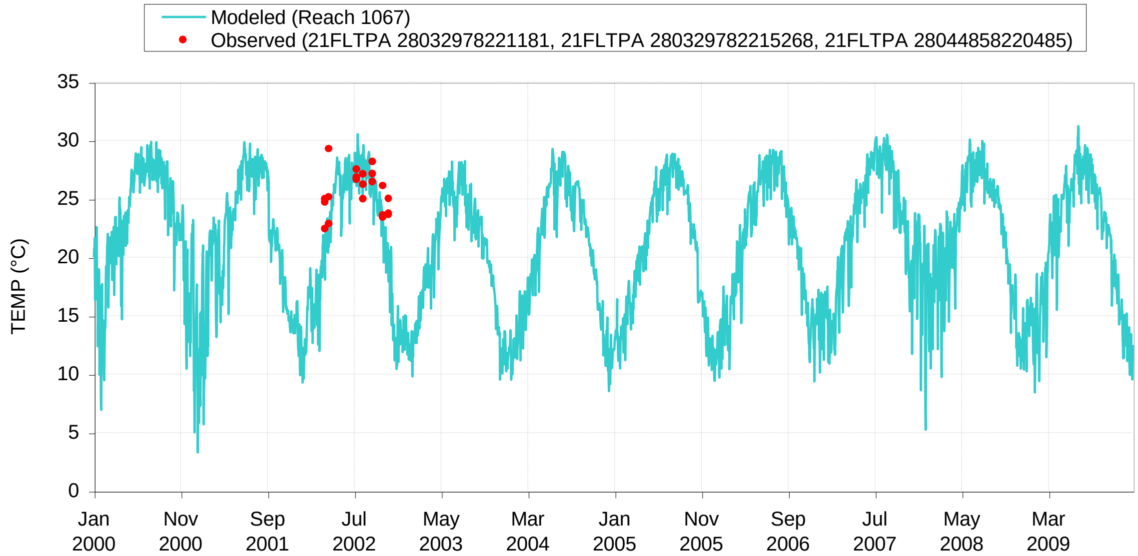


Figure 7.14 Modeled vs. Observed TEMP (°C) at 21FLTPA 28032978221181, 21FLTPA 280329782215268, and 21FLTPA 28044858220485 in WBID 1534

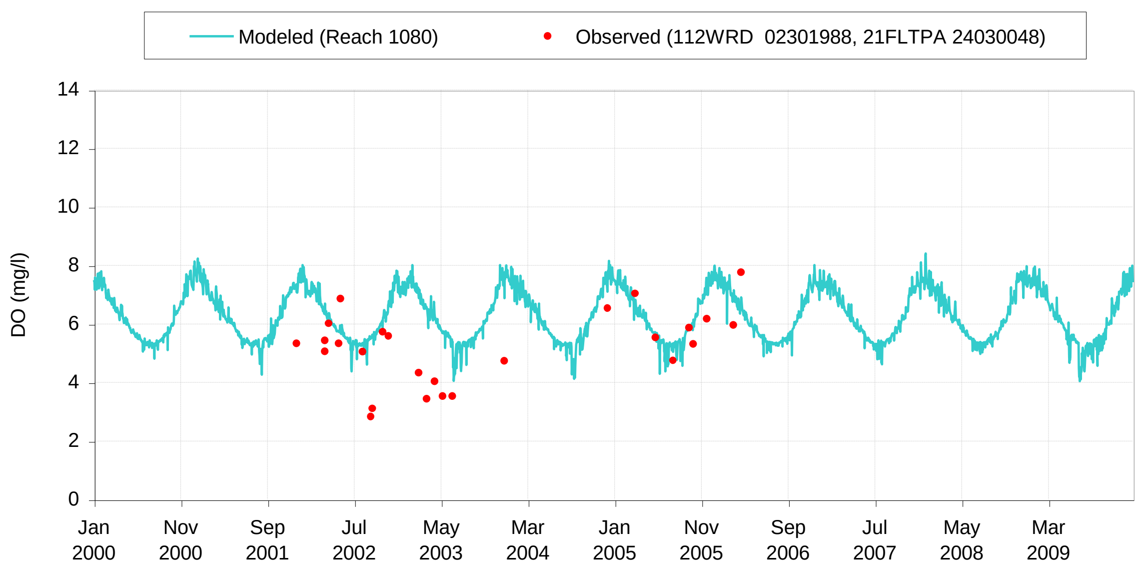


Figure 7.15 Modeled vs. Observed DO (mg/l) at 112WRD 02301988 and 21FLTPA 24030048 in WBID 1443A

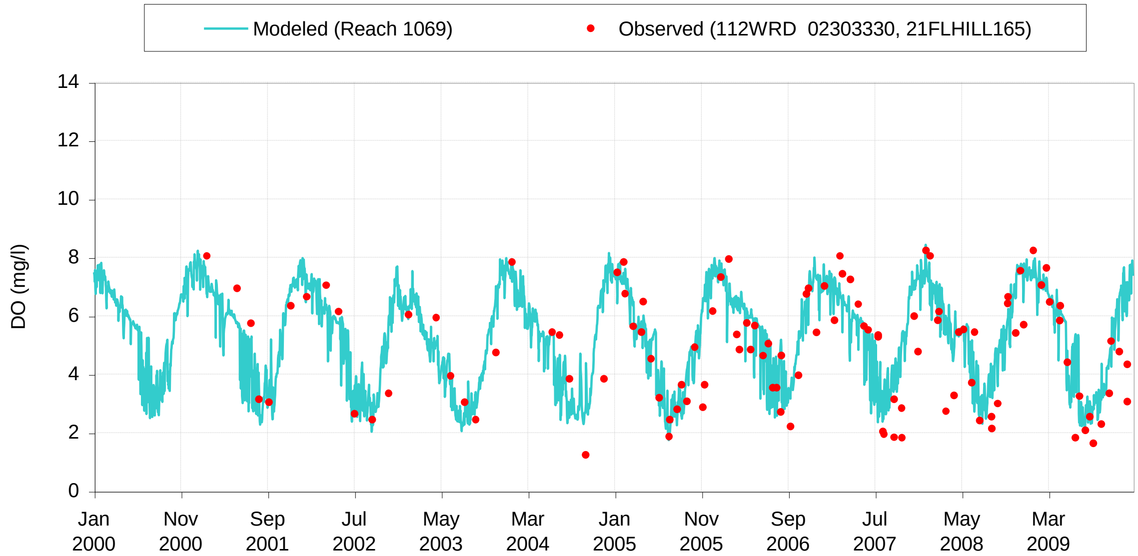


Figure 7.16 Modeled vs. Observed DO (mg/l) at 112WRD 02303330 and 21FLHILL165 in 1443B

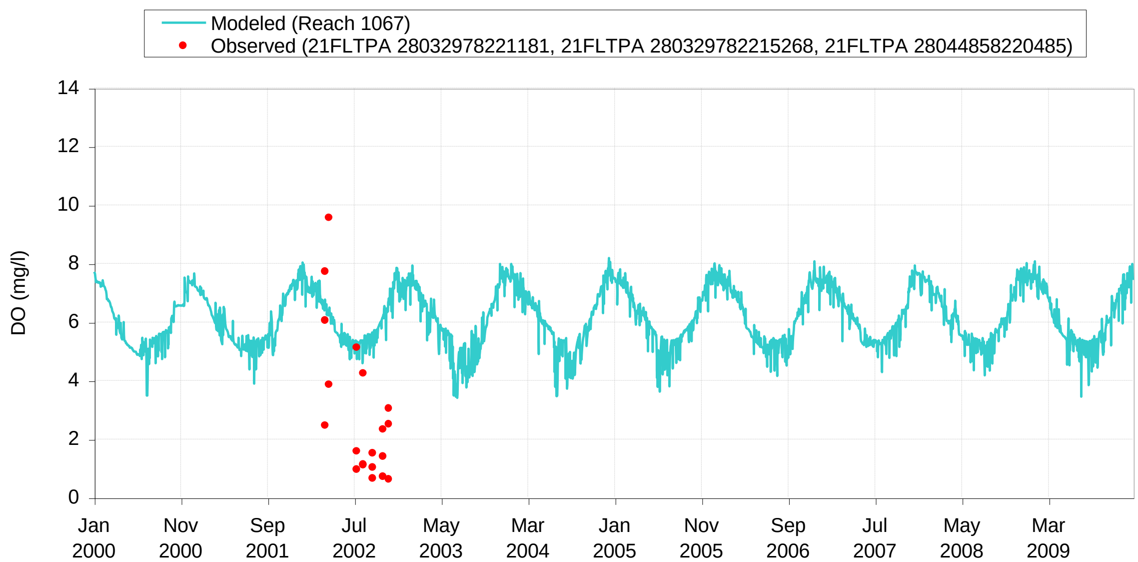


Figure 7.17 Modeled vs. Observed DO (mg/l) at 21FLTPA 28032978221181, 21FLTPA 280329782215268, and 21FLTPA 28044858220485 in WBID 1534

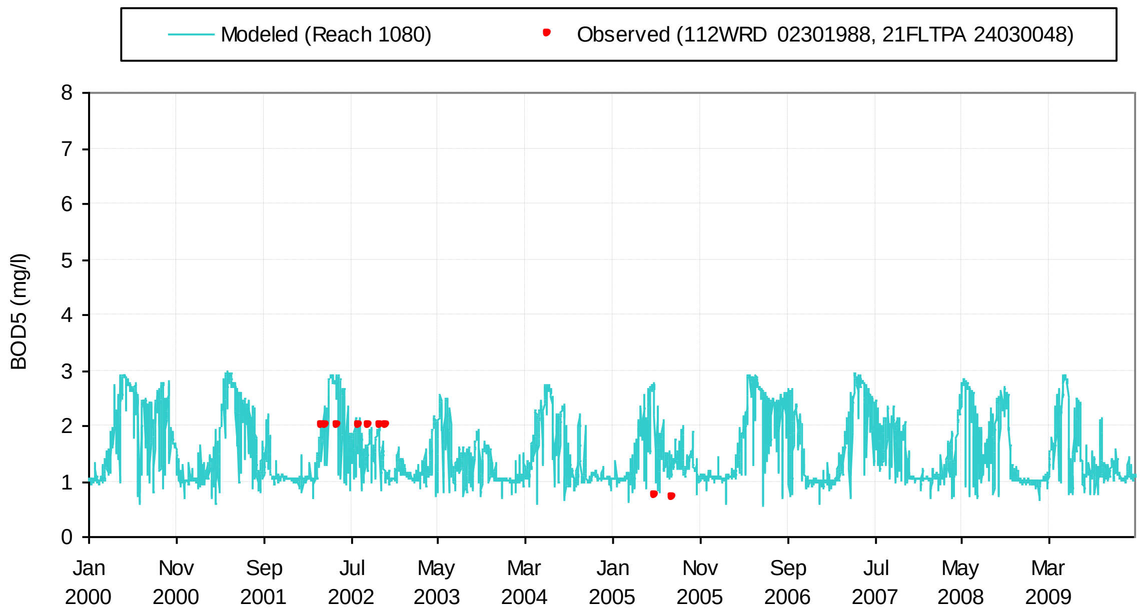


Figure 7.18 Modeled vs. Observed BOD5 (mg/l) at 112WRD 02301988 and 21FLTPA 24030048 in WBID 1443A

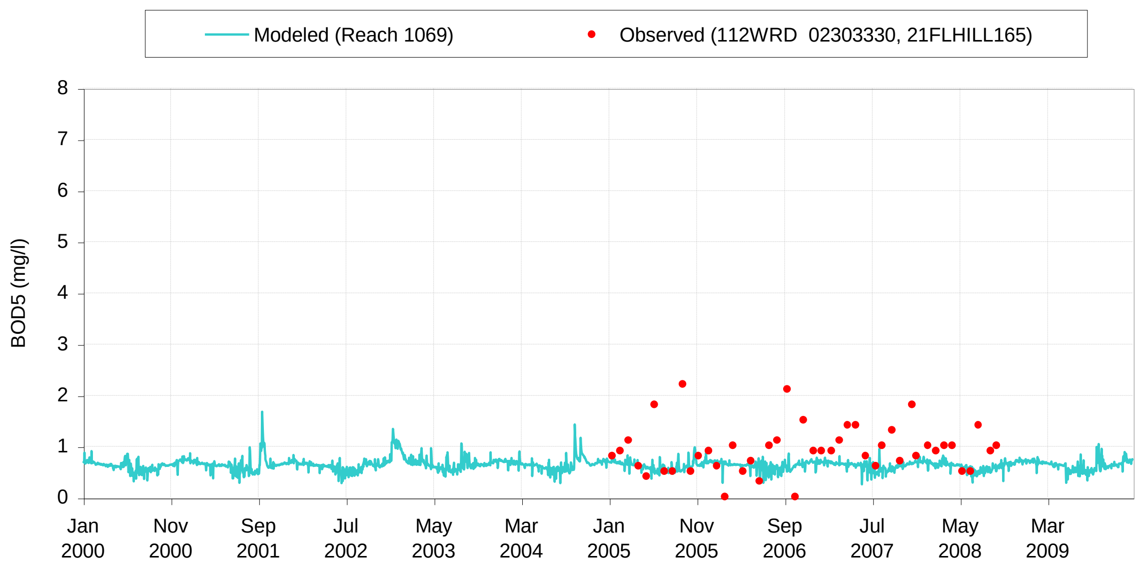


Figure 7.19 Modeled vs. Observed BOD5 (mg/l) at 112WRD 02303330 and 21FLHILL165 in 1443B

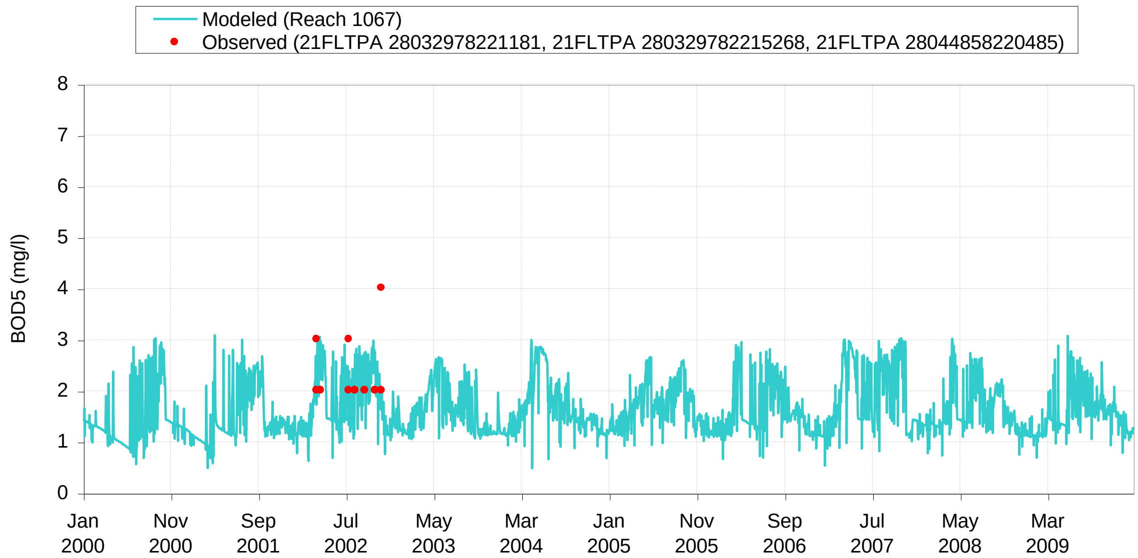


Figure 7.16 Modeled vs. Observed BOD5 (mg/l) at 21FLTPA 28032978221181, 21FLTPA 280329782215268, and 21FLTPA 28044858220485 in WBID 1534

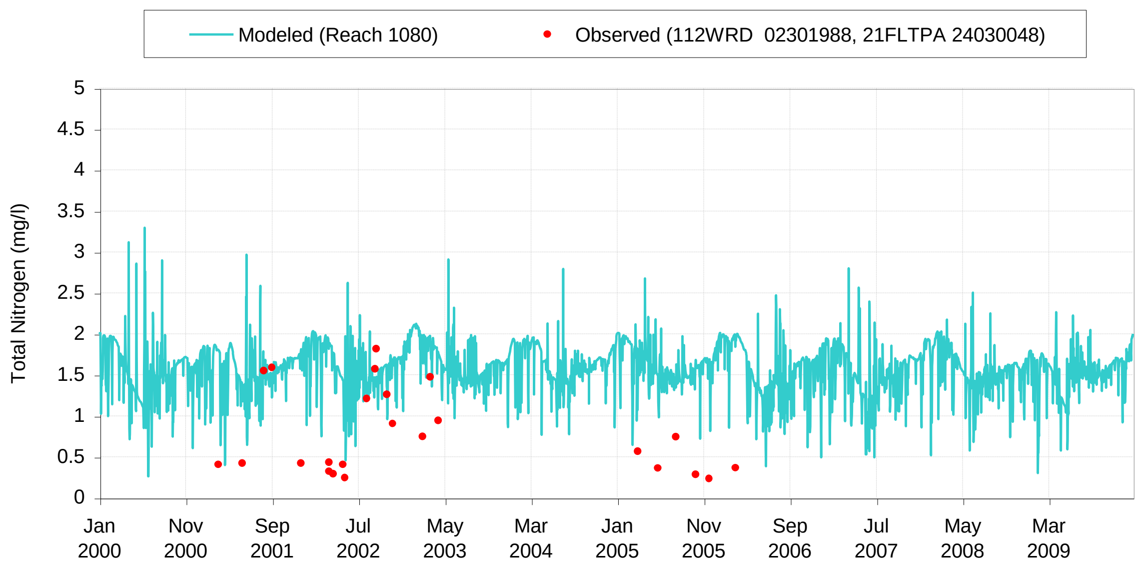


Figure 7.17 Modeled vs. Observed Total Nitrogen (mg/l) at 112WRD 02301988 and 21FLTPA 24030048 in WBID 1443A

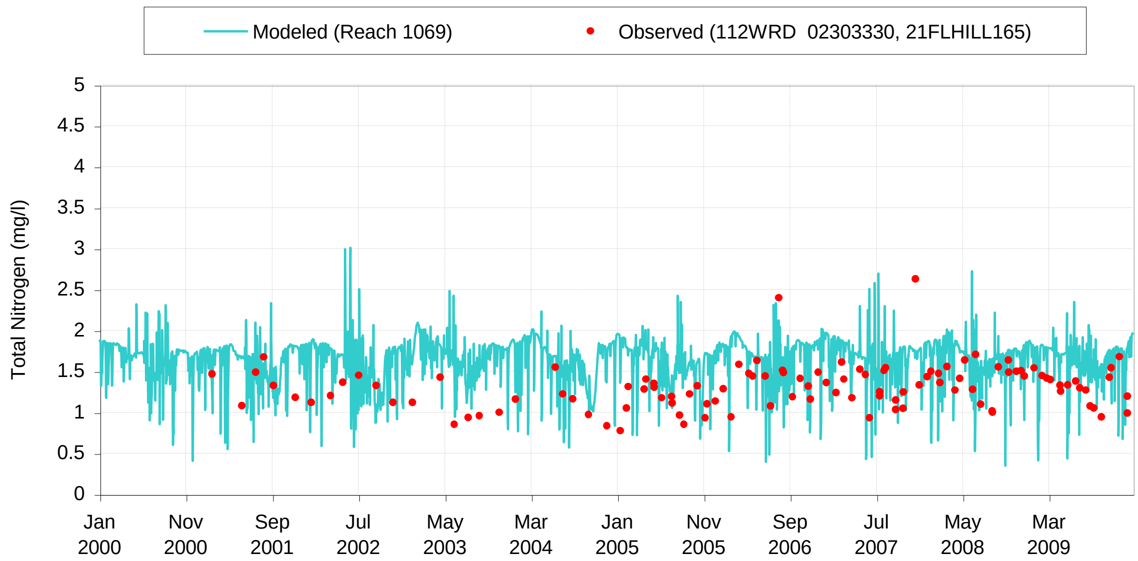


Figure 7.22 Modeled vs. Observed Total Nitrogen (mg/l) at 112WRD 02303330 and 21FLHILL165 in 1443B

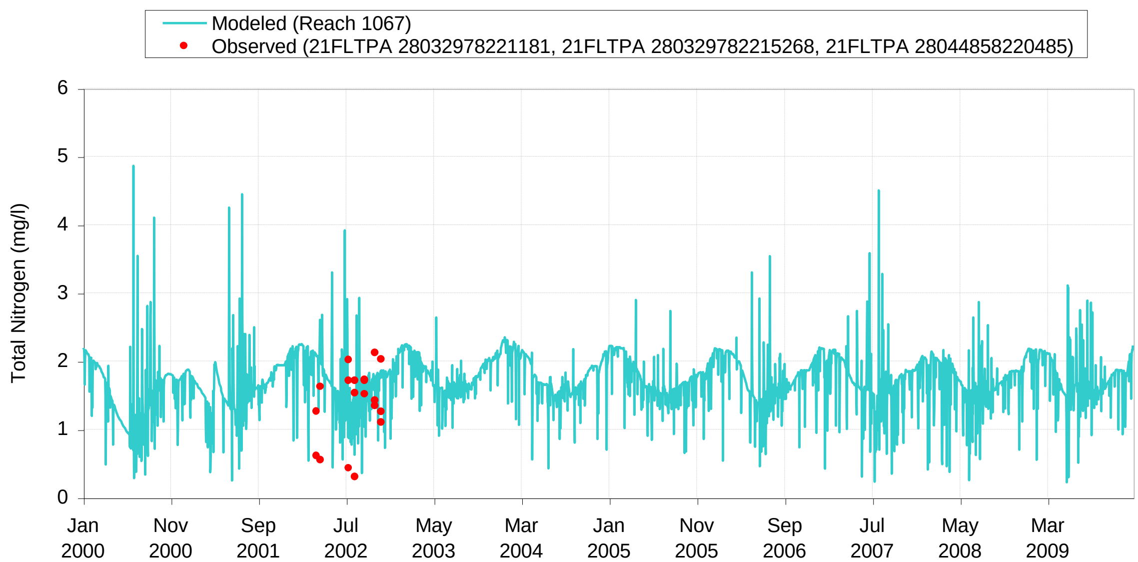


Figure 7.23 Modeled vs. Observed Total Nitrogen (mg/l) at 21FLTPA 28032978221181, 21FLTPA 280329782215268, and 21FLTPA 28044858220485 in WBID 1534

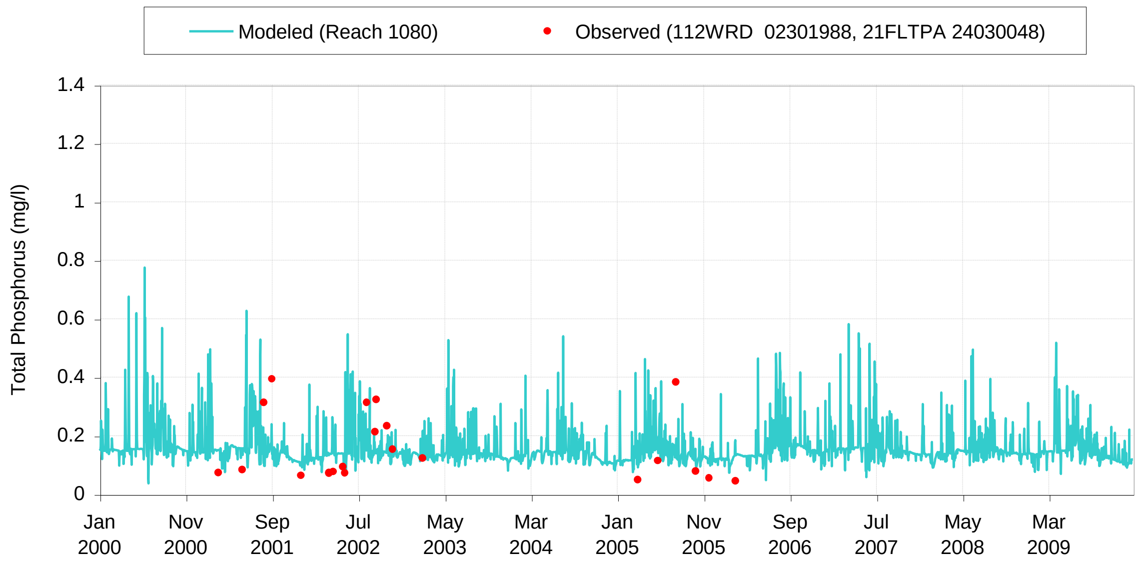


Figure 7.24 Modeled vs. Observed Total Phosphorus (mg/l) at 112WRD 02301988 and 21FLTPA 24030048 in WBID 1443A

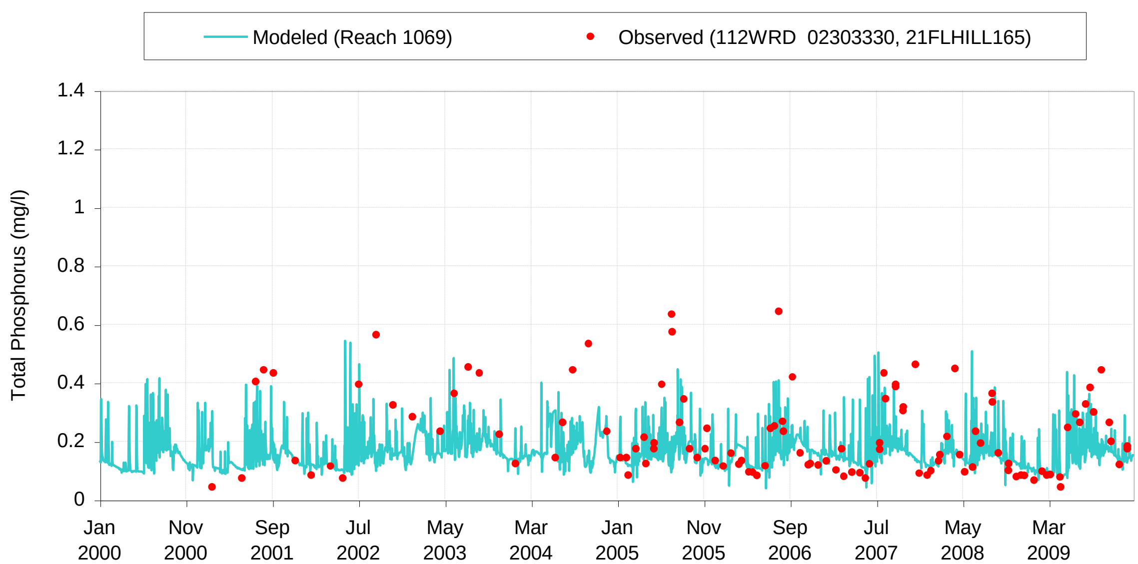


Figure 7.218 Modeled vs. Observed Total Phosphorus (mg/l) at 112WRD 02303330 and 21FLHILL165 in 1443B

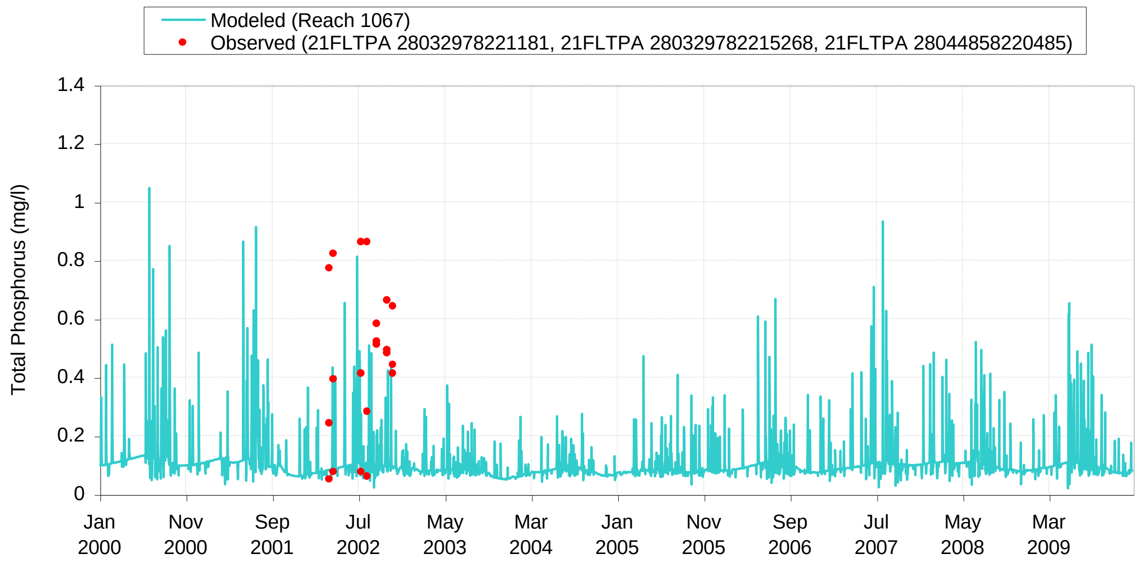


Figure 7.19 Modeled vs. Observed Total Phosphorus (mg/l) at 21FLTPA 28032978221181, 21FLTPA 280329782215268, and 21FLTPA 28044858220485 in WBID 1534

### 7.1.2 Environmental Fluids Dynamic Code (EFDC)

The EFDC model is a part of the USEPA TMDL Modeling Toolbox due to its application in many TMDL-type projects. As such, the code has been peer reviewed and tested and has been freely distributed and supported by Tetra Tech. EFDC was developed by Dr. John Hamrick (Hamrick 1992) and is currently supported by Tetra Tech for USEPA Office of Research and Development (ORD), USEPA Region 4, and USEPA Headquarters. The models, tools, and databases in the TMDL Modeling Toolbox are continually updated and upgraded through TMDL development in Region 4. EFDC is a multifunctional, surface-water modeling system, which includes hydrodynamic, sediment contaminant, and eutrophication components. The EFDC model is capable of 1, 2, and 3-dimensional spatial resolution. The model employs a curvilinear-orthogonal horizontal grid and a sigma or terrain following vertical grid.

The EFDC hydrodynamic model can run independently of a water quality model. The EFDC model simulates the hydrodynamic and constituent transport and then writes a hydrodynamic linkage file for a water quality model such as the Water Quality Analysis Program (WASP7) model. This model linkage, from EFDC hydrodynamics to WASP water quality, has been applied on many USEPA Region 4 projects in support of TMDLs and has been well tested (Wool et al. 2003).

The EFDC model was utilized to simulate three-dimensional circulation dynamics of hydrodynamic state variables (water surface elevation, salinity, and temperature) in the Hillsborough River estuary. The Hillsborough River model utilized the Tampa Bay EFDC model that was created for the Florida Numeric Nutrient Criteria (NNC), which was resized to meet the modeling needs of Hillsborough River. The Tampa Bay EFDC model was created using NOAA bathymetric data.

The EFDC model predicts water surface elevation, salinity, and temperature, in response to a set of multiple factors: wind speed and direction, freshwater discharge, tidal water level fluctuation, rainfall, surface heat flux, and temperature and salinity associated with boundary fluxes. Hourly measurements of atmospheric pressure, dry and wet bulb atmospheric temperatures, rainfall rate, wind speed and direction, and fractional cloud cover were obtained from data collected at the Tampa WBAN station for 2002 through 2009. Solar short wave radiation was calculated using the CE-Qual-W2 method.

The Tampa Bay estuary model used hourly water surface elevation time series data from the National Oceanic and Atmospheric Administration (NOAA) tidal stations to simulate tides at the open boundary. Observed temperature data at water quality stations were used to simulate the temperature at the open boundaries, and average salinity in Tampa Bay was used to simulate salinity. The Tampa Bay NNC Estuary was calibrated to measured NOAA tidal stations, and the Tampa Bay model was used to simulate the open boundary conditions in the Hillsborough River Estuary model. The upstream inland boundary grid cell received LSPC simulated watershed discharge from LSPC subwatershed 1694.

The Hillsborough River EFDC grid consisted of 40 cells, specifically 20 cells in the horizontal direction and two layers in the vertical direction (Figure 7.20). The grid was developed using bathymetry data from NOAA. Bathymetry was unavailable for the inland, tidally influenced streams, and channel slope from the USGS digital elevation model was used to estimate slope within the channel. The Hillsborough River grid extended from the Tampa Bay into Hillsborough River to the Hillsborough River Dam.

Because there were no NOAA tidal stations located within the Hillsborough River estuary, water surface elevation within the modeled cells could not be directly calibrated. Salinity measurements from IWR44 data were used to review the Hillsborough River estuary EFDC calibration. Following the model review, the salinity and temperature parameters were adjusted accordingly (Figure 7.28 through Figure 7.31).

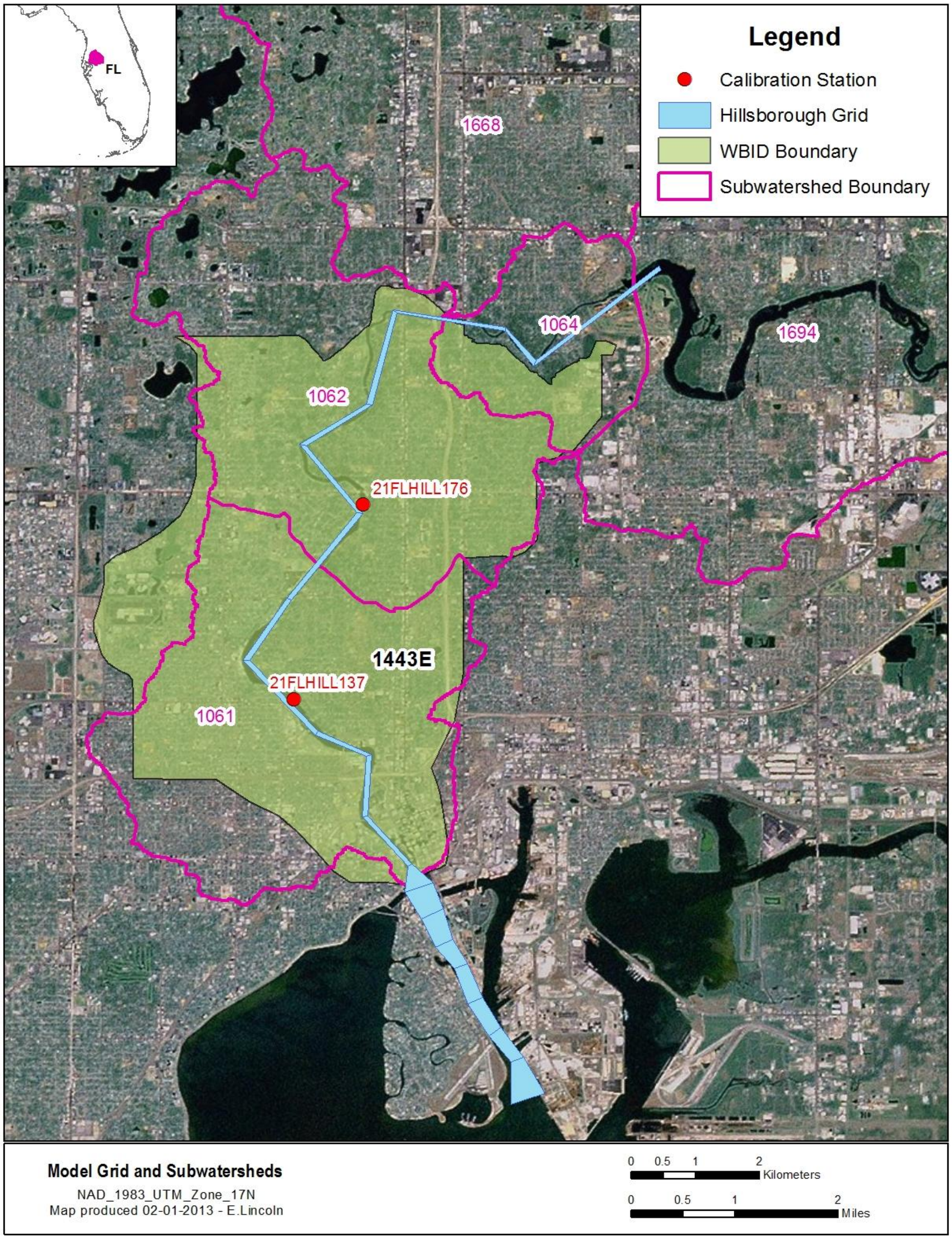


Figure 7.20 LSPC subwatershed boundaries, estuary model grid, and estuary calibration stations for the Hillsborough River

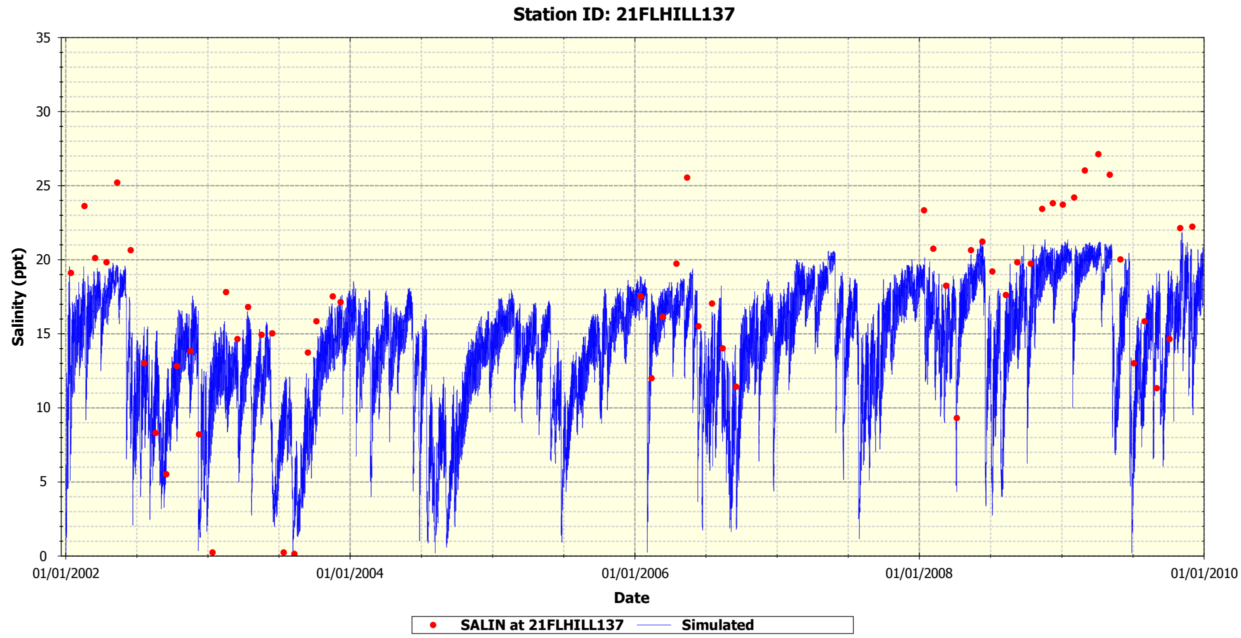


Figure 7.28 Modeled vs. observed salinity (ppt) at station 21FLHILL137 in WBID 1443E

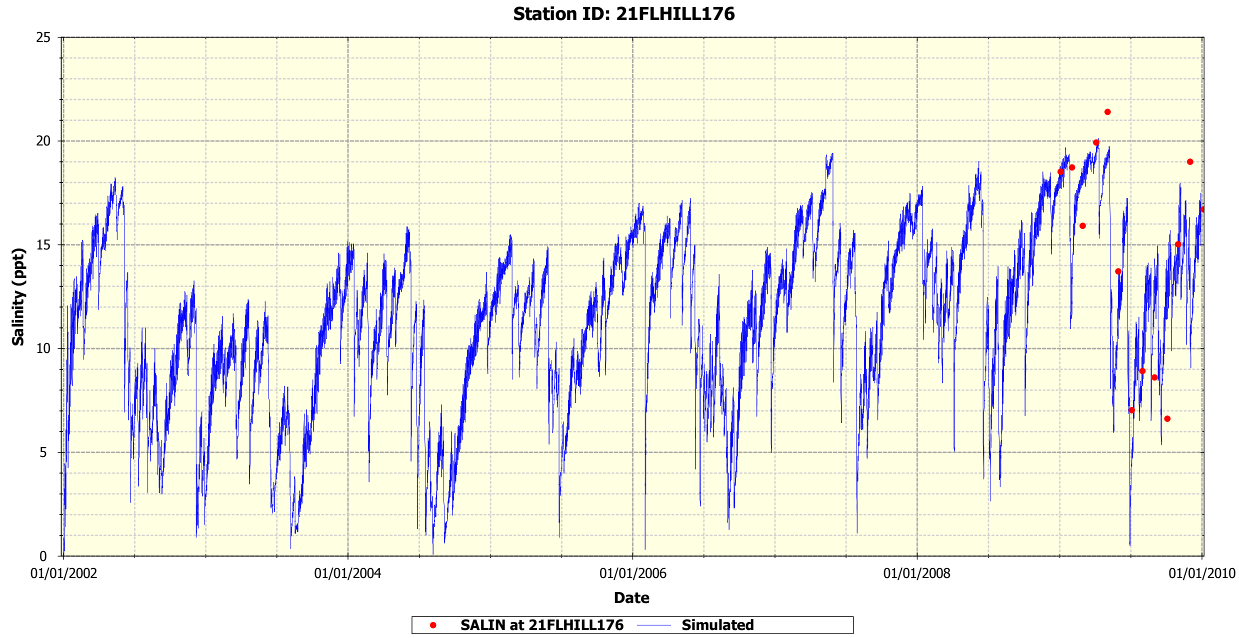


Figure 7.29 Modeled vs. observed salinity (ppt) at station 21FLHILL176 in WBID 1443E

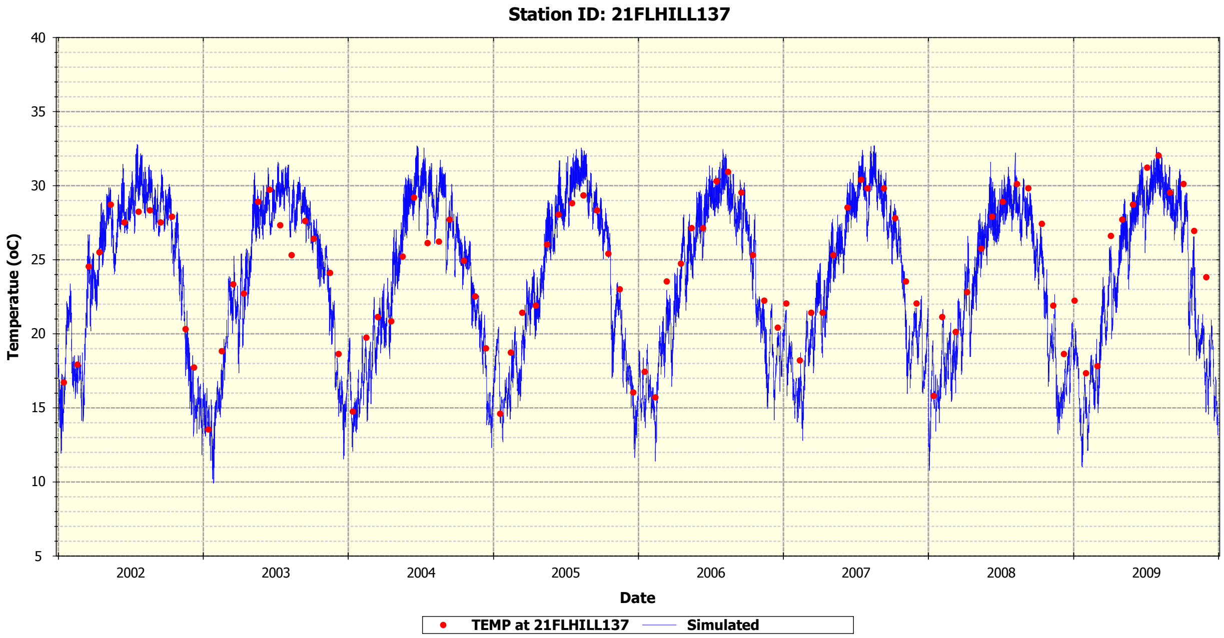


Figure 7.30 Modeled vs. observed temperature at station 21FLHILL137 in WBID 1443E

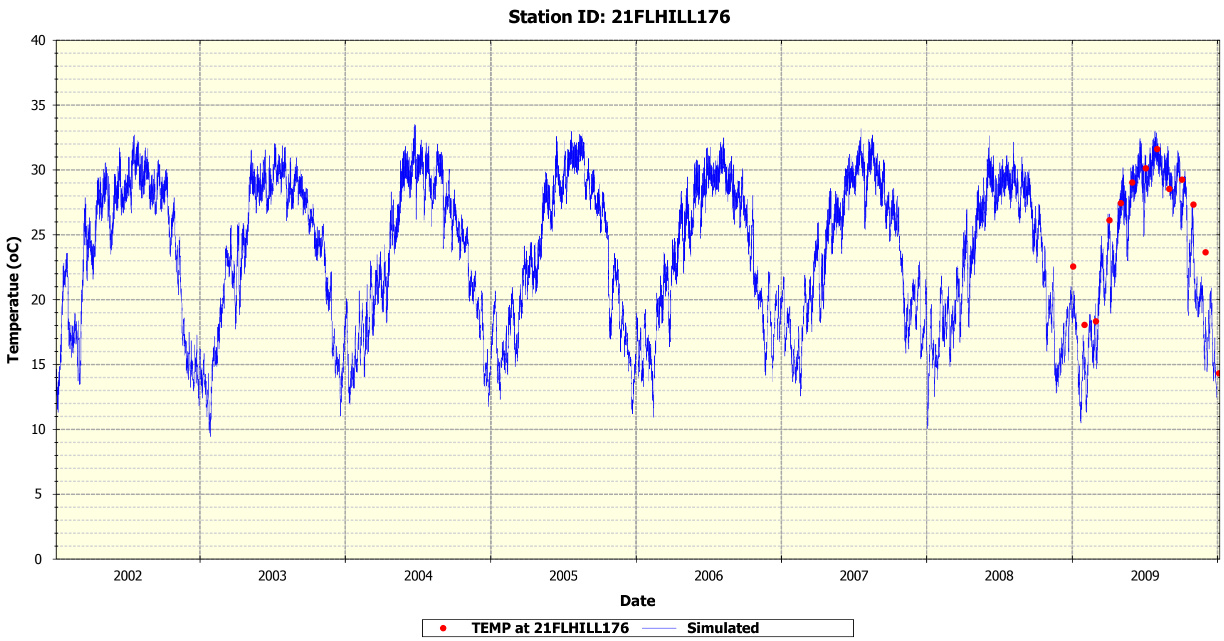


Figure 7.31 Modeled vs. observed temperature at station 21FLHILL176 in WBID 1443E

### 7.1.3 Water Quality Analysis Simulation Program (WASP7)

The Water Quality Analysis Simulation Program Version 7.4.1 (WASP7) is an enhanced Windows version of the USEPA Water Quality Analysis Simulation Program (WASP) (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988), with upgrades to the user's interface and the model's capabilities. The major upgrades to WASP have been the addition of multiple BOD components, addition of sediment diagenesis routines, and addition of periphyton routines. The hydrodynamic file generated by EFDC is compatible with WASP7 and it transfers segment volumes, velocities, temperature and salinity, as well as flows between segments. The time step is set in WASP7 based on the hydrodynamic simulation.

WASP7 helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP7 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic program. The purpose of the WASP7 water quality modeling was to reproduce the three-dimensional transport and chemical and biological interactions of major components of water quality in the Hillsborough River estuary.

WASP7 modeled total nitrogen (TN) and its speciation, total phosphorus (TP) and its speciation, chlorophyll-a, dissolved oxygen, and carbonaceous biochemical oxygen demand (CBOD). The model predicts these parameters in response to a set of hydrological, meteorological, atmospheric, and chemical and biological factors: loads from point and nonpoint sources, benthic ammonia and phosphate fluxes, sediment oxygen demand (SOD), solar radiation, air temperature, reaeration, offshore and inland boundary conditions.

The Hillsborough River WASP7 model utilized the same grid cells that were developed for the Hillsborough River EFDC model. The hydrodynamic simulation from the Hillsborough River EFDC model was input into the WASP7 model. Open boundary water quality conditions used measured water quality data from Tampa Bay. Water quality loading from the LSPC model was used to simulate loads coming from rivers and streams into the estuary.

Water quality parameters from the Tampa Bay NNC WASP model were used for initial parameter population for the Hillsborough River WASP7 model. The Hillsborough River estuary model calibration was reviewed against water quality data located in IWR44. Following the review, the calibration was adjusted accordingly to provide the best existing scenario model calibration for the water quality parameters of concern. Results at select water quality stations are presented in Figure 7.32 through Figure 7.41.

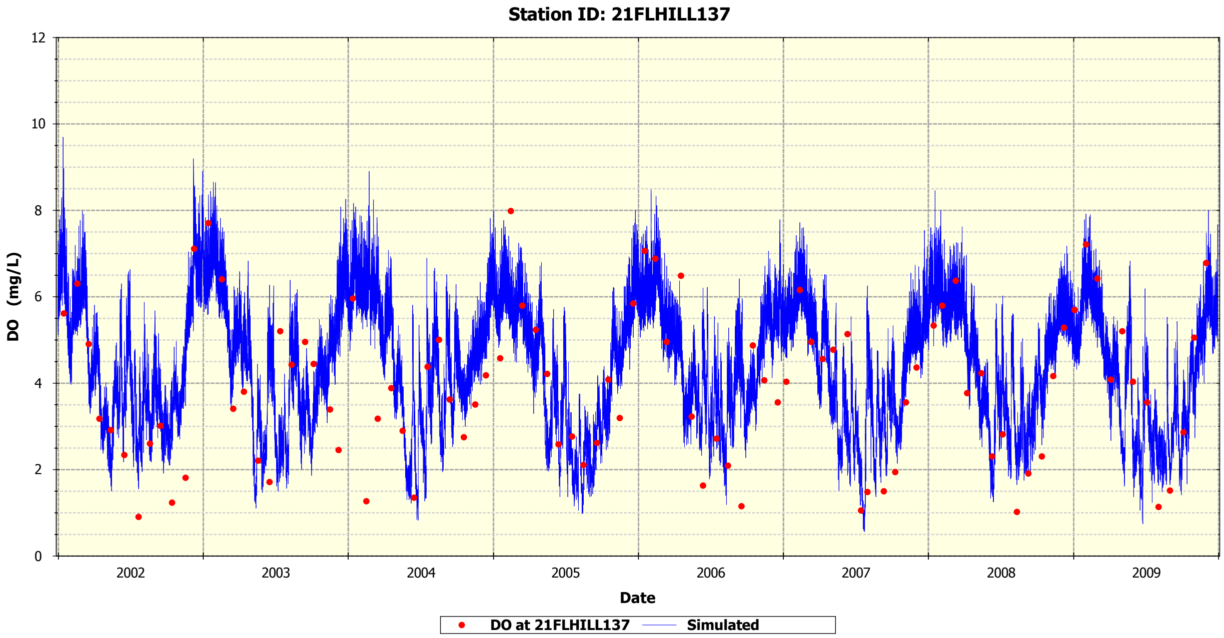


Figure 7.32 Modeled vs. observed dissolved oxygen at station 21FLHILL137 in WBID 1443E

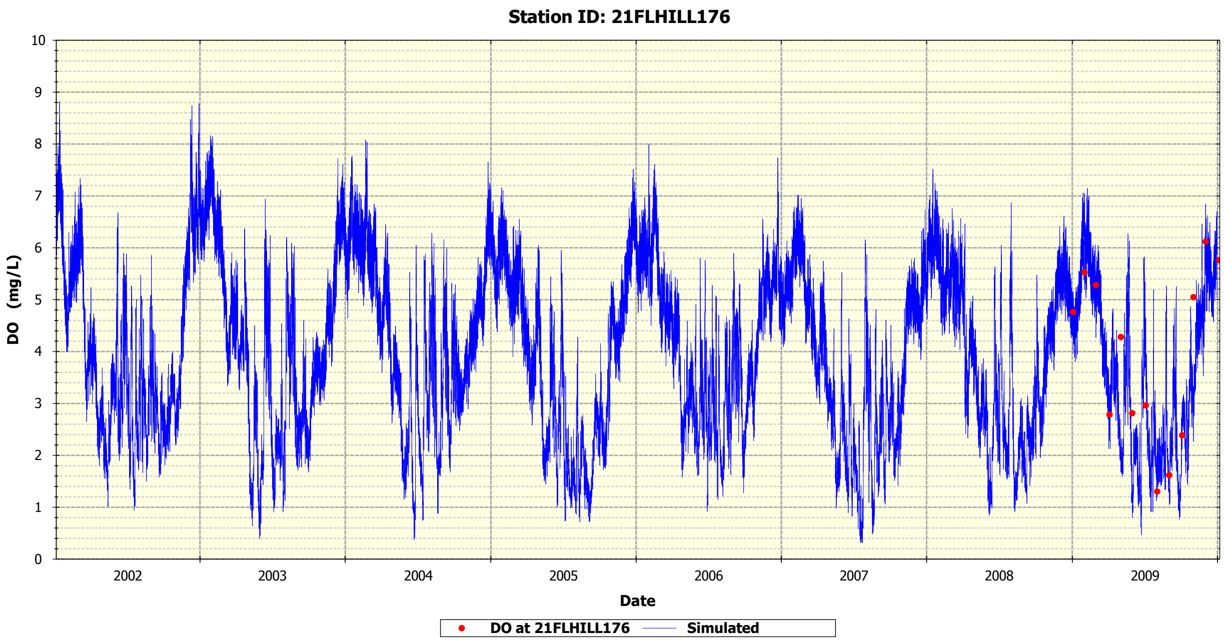


Figure 7.33 Modeled vs. observed dissolved oxygen at station 21FLHILL176 in WBID 1443E

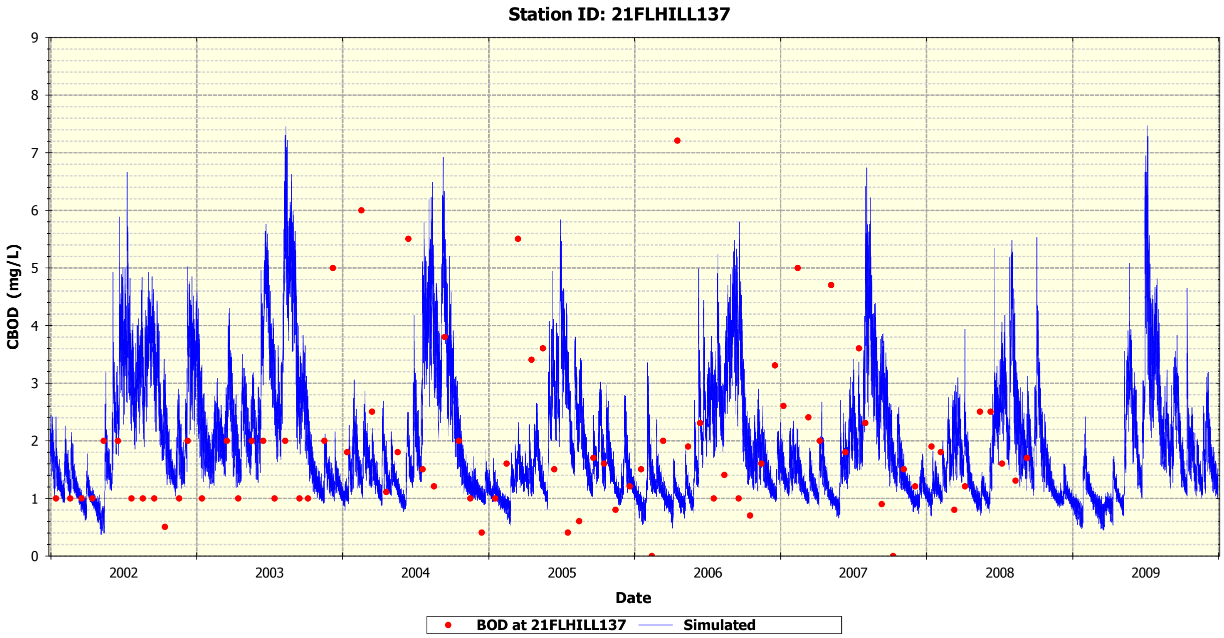


Figure 7.34 Modeled vs. observed CBOD at station 21FLHILL137 in WBID 1443E

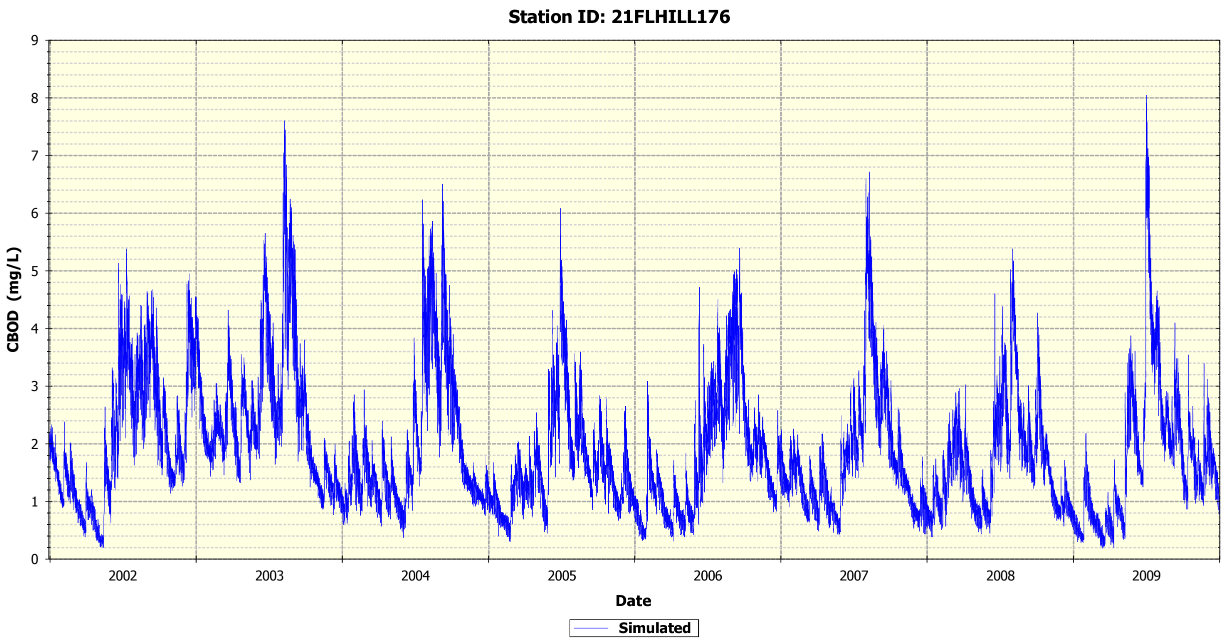


Figure 7.35 Modeled CBOD at station 21FLHILL176 in WBID 1443E, no observed data available

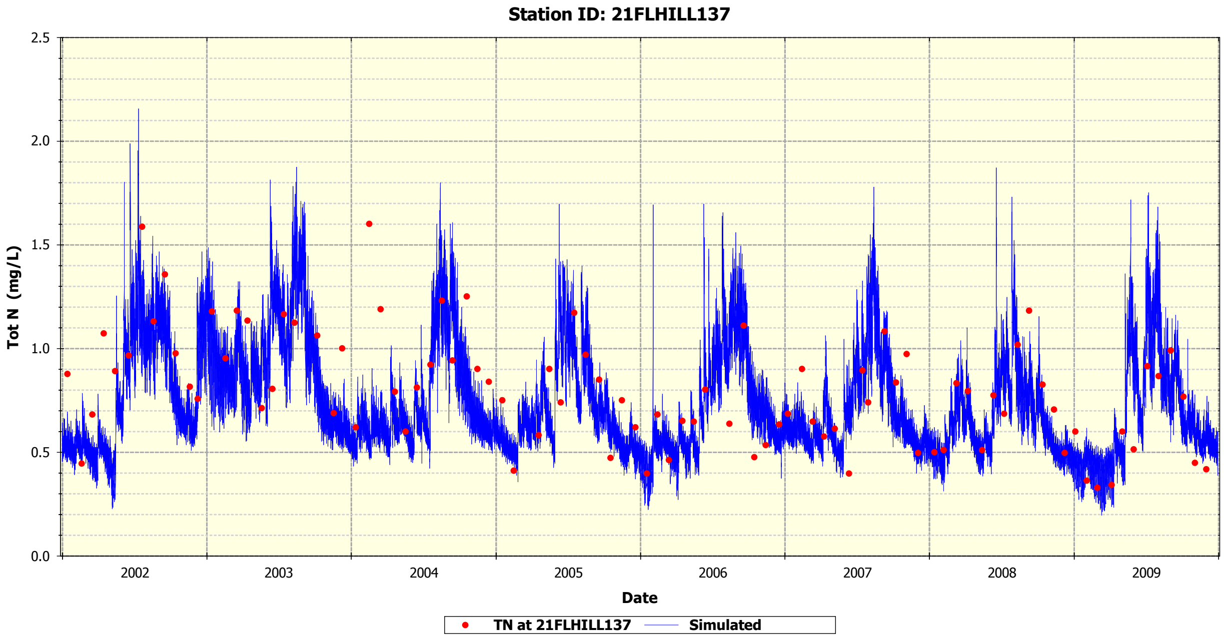


Figure 7.36 Modeled vs. observed total nitrogen at station 21FLHILL137 in WBID 1443E

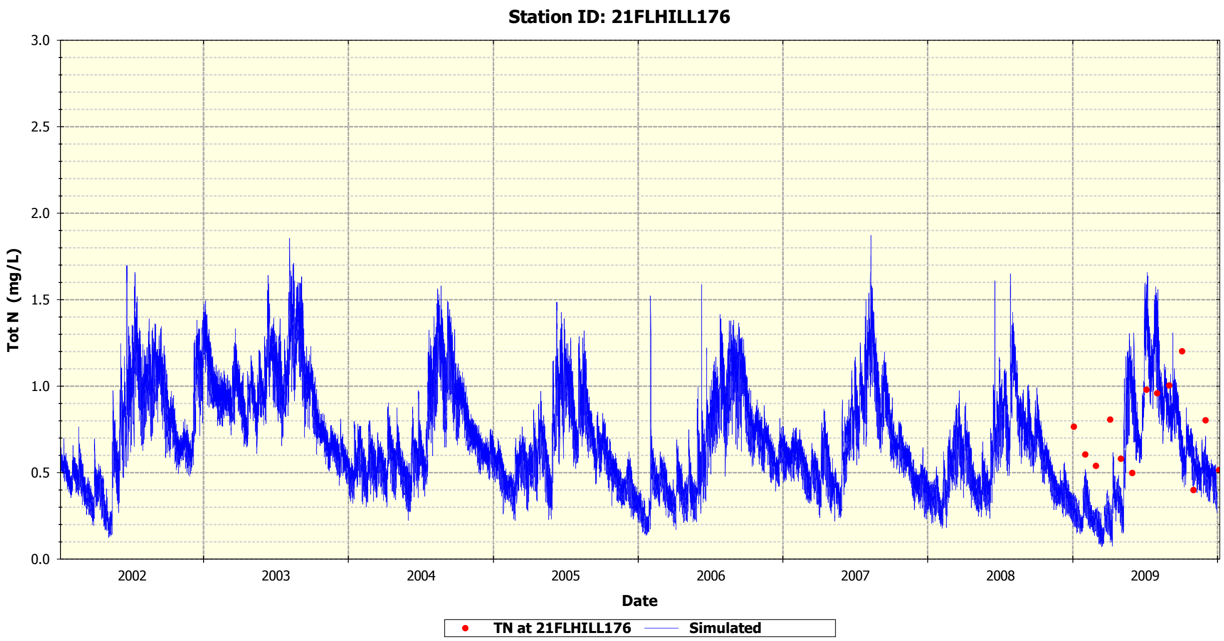


Figure 7.37 Modeled vs. observed total nitrogen at station 21FLHILL176 in WBID 1443E

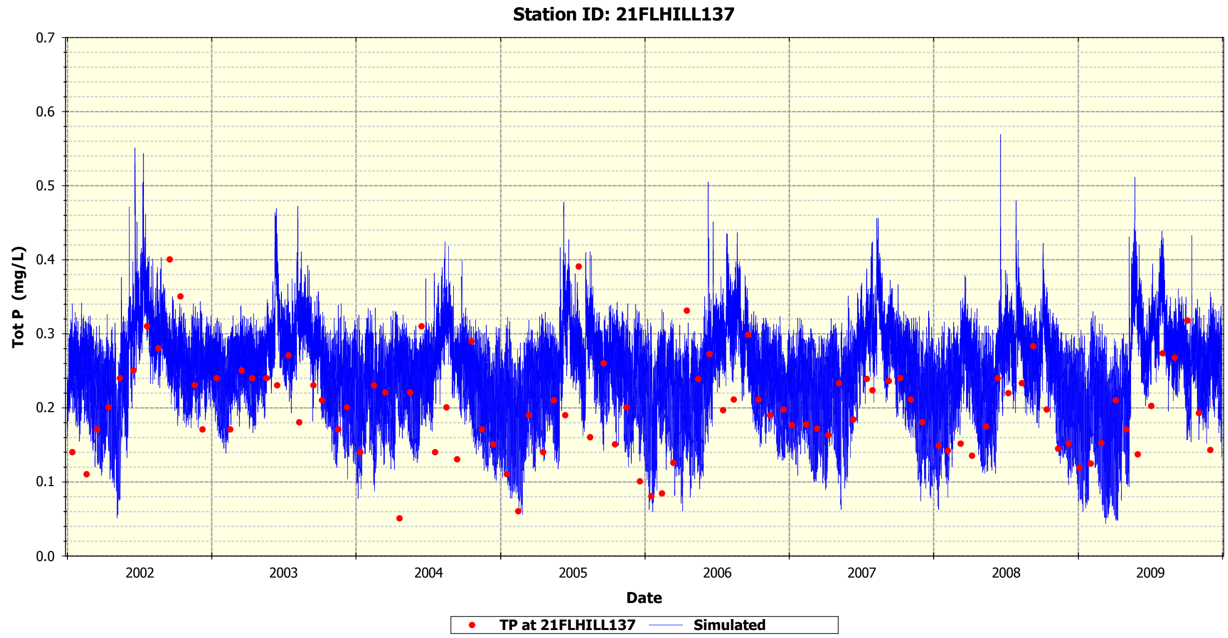


Figure 7.38 Modeled vs. observed total phosphorus at station 21FLHILL137 in WBID 1443E

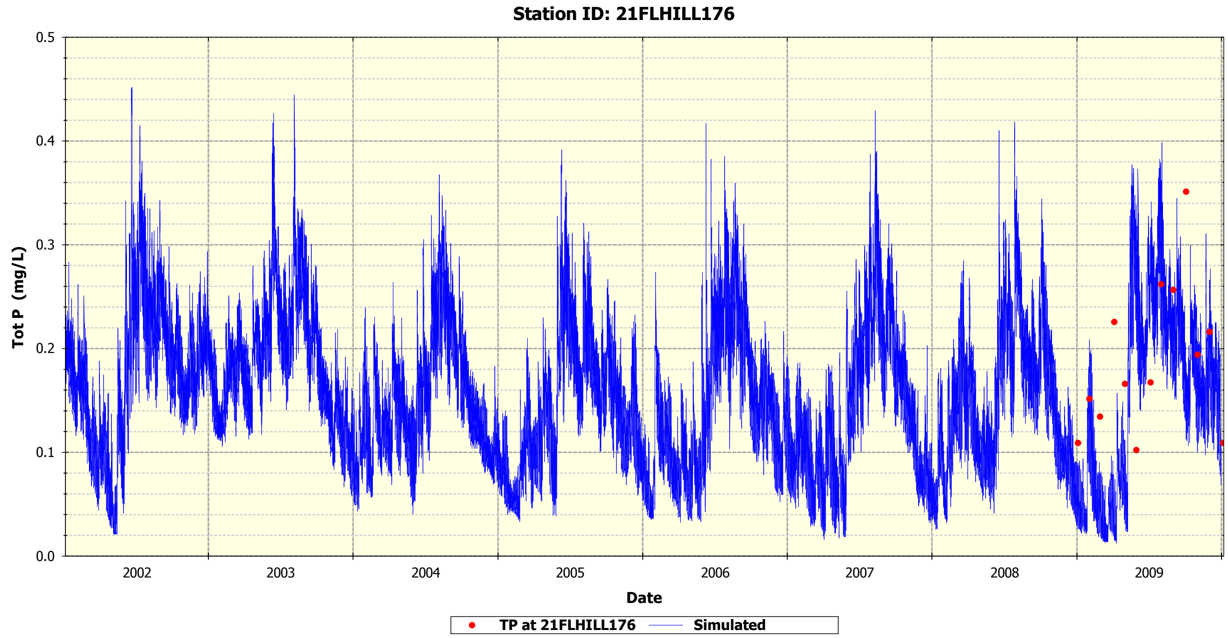


Figure 7.39 Modeled vs. observed total phosphorus at station 21FLHILL176 in WBID 1443E

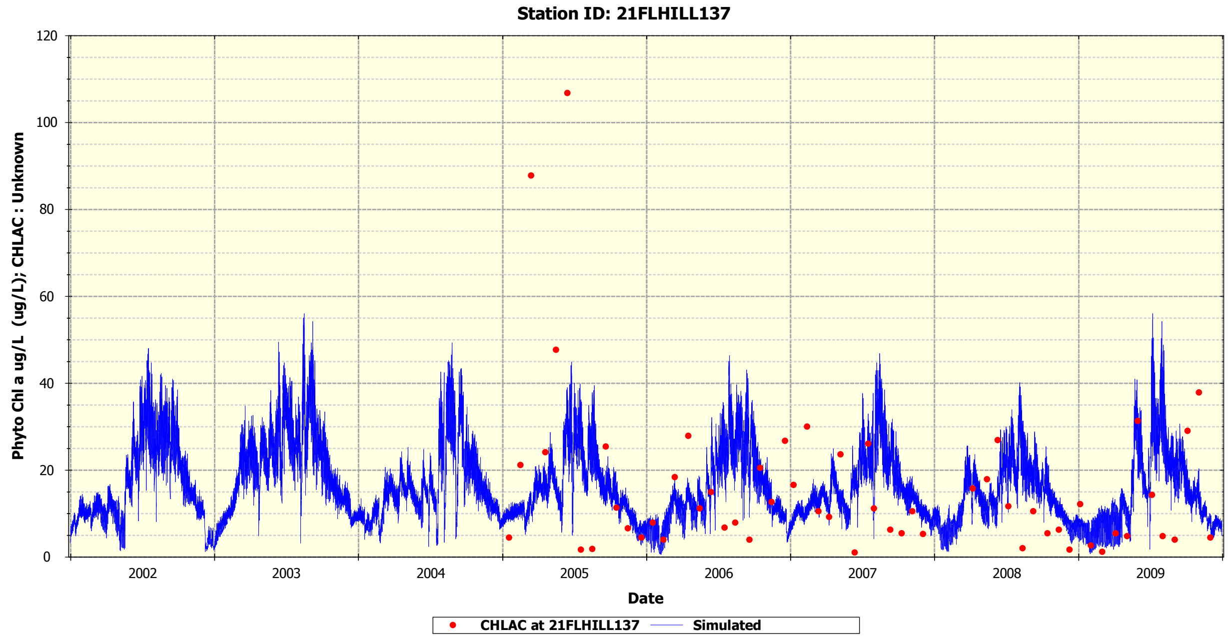


Figure 7.40 Modeled vs. observed total chlorophyll a at station 21FLHILL137 in WBID 1443E

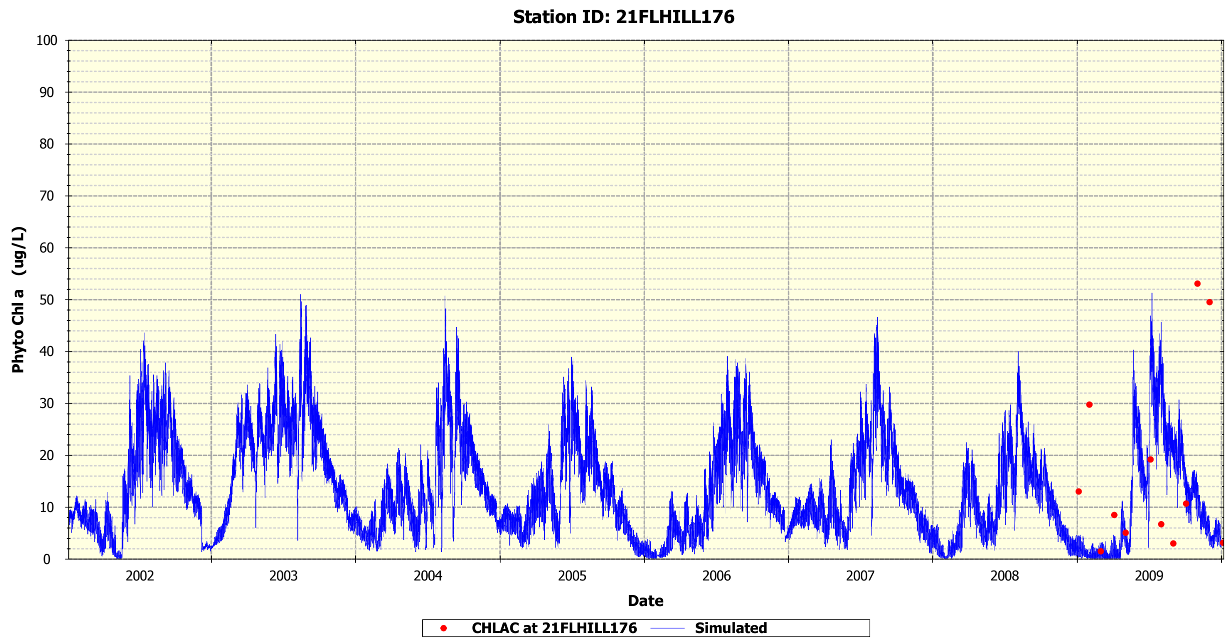


Figure 7.41 Modeled vs. observed total chlorophyll a at station 21FLHILL176 in WBID 1443E

## *7.2 Scenarios*

Two modeling scenarios were developed and evaluated in this TMDL determination: a current condition and a natural condition scenario. Concentrations and loadings were evaluated to determine if DO concentrations in the natural condition scenario could meet the DO standard, and the impact of nutrients on the DO concentrations. The results from the scenarios were used to develop the TMDL.

### 7.2.1 Current Condition

The current condition scenario evaluated current hydrologic and water quality conditions in the watershed, specifically water quality concentration and loadings at the outlet of 1443A, 1443B, 1443E, and 1534. The current condition annual average concentrations for each of the WBIDs are presented in Table 7.1. The current condition simulation was used to determine the base loadings for each of the WBIDs. These base loadings (Table 7.2), when compared with the TMDL scenarios, were used to determine the percent reduction in nutrient loads that will be needed to achieve water quality standards. Water quality calibration figures can be found in sections 7.1.1 and section 7.1.3.

Table 7.1 Current condition concentrations in the impaired WBIDs

| Parameter | WBID 1443A | WBID 1443B | WBID 1443E | WBID 1534 |
|---|---|---|---|---|
| Total nitrogen (mg/L) | 1.57 | 1.57 | 0.73 | 1.71 |
| Total phosphorus (mg/L) | 0.16 | 0.16 | 0.25 | 0.11 |
| BOD (mg/L) | 1.54 | 0.58 | 1.94 | 1.62 |
| DO (mg/L) | 6.28 | 4.49 | 4.40 | 6.14 |

Table 7.2 Current condition loadings in the impaired WBIDs

| Parameter | WBID 1443A | WBID 1443B | WBID 1443E | WBID 1534 |
|---|---|---|---|---|
| | LA (kg/yr) | LA (kg/yr) | LA (kg/yr) | LA (kg/yr) |
| Total nitrogen (mg/L) | 78,558 | 443,246 | 357,542 | 11,132 |
| Total phosphorus (mg/L) | 7,651 | 53,832 | 78,035 | 753 |
| BOD (mg/L) | 70,284 | 192,403 | 153,503 | 11,855 |

### 7.2.2 Natural Condition

The natural condition scenario was developed to estimate water quality conditions if there was no impact from anthropogenic sources. The point sources located in the model were removed for the natural condition analysis. Land uses that were associated with anthropogenic activities (urban, agriculture, transportation, barren lands and rangeland) were converted to upland forests or forested wetlands based on the current ration of forest and wetland land uses in the model. The natural condition water quality predictions are presented in Table 7.3 and Table 7.4.

The purpose of the natural conditions scenario was to determine whether water quality standards could be achieved without abating the naturally occurring loads from the watershed. The natural condition modeling scenario indicated that the DO standard is not achievable under natural conditions, indicating that low DO is a naturally occurring phenomenon in the impaired WBIDs (Figure 7.42 through Figure 7.46). Figure 7.47 through Figure 7.50 provide the cumulative distribution function of DO concentrations for both the modeled existing condition and natural condition results. The cumulative distribution curve shows there is an increase in DO concentrations in the natural condition scenario, specifically in DO concentration values less than 5 mg/L in the existing condition run.

Table 7.3 Natural condition concentrations in the impaired WBIDs

| Parameter | WBID 1443A | WBID 1443B | WBID 1443E | WBID 1534 |
|---|---|---|---|---|
| Total nitrogen (mg/L) | 0.54 | 1.13 | 0.49 | 0.53 |
| Total phosphorus (mg/L) | 0.02 | 0.03 | 0.24 | 0.02 |
| BOD (mg/L) | 1.61 | 0.58 | 1.69 | 1.67 |
| DO (mg/L) | 6.32 | 4.77 | 5.70 | 6.29 |

Table 7.4 Natural condition loadings in the impaired WBIDs

| Parameter | WBID 1443A | WBID 1443B | WBID 1443E | WBID 1534 |
|---|---|---|---|---|
| | LA (kg/yr) | LA (kg/yr) | LA (kg/yr) | LA (kg/yr) |
| Total nitrogen (mg/L) | 36,946 | 225,723 | 148,517 | 5,054 |
| Total phosphorus (mg/L) | 1119 | 8451 | 6169 | 130 |
| BOD (mg/L) | 50,532 | 141,301 | 161,092 | 7,640 |

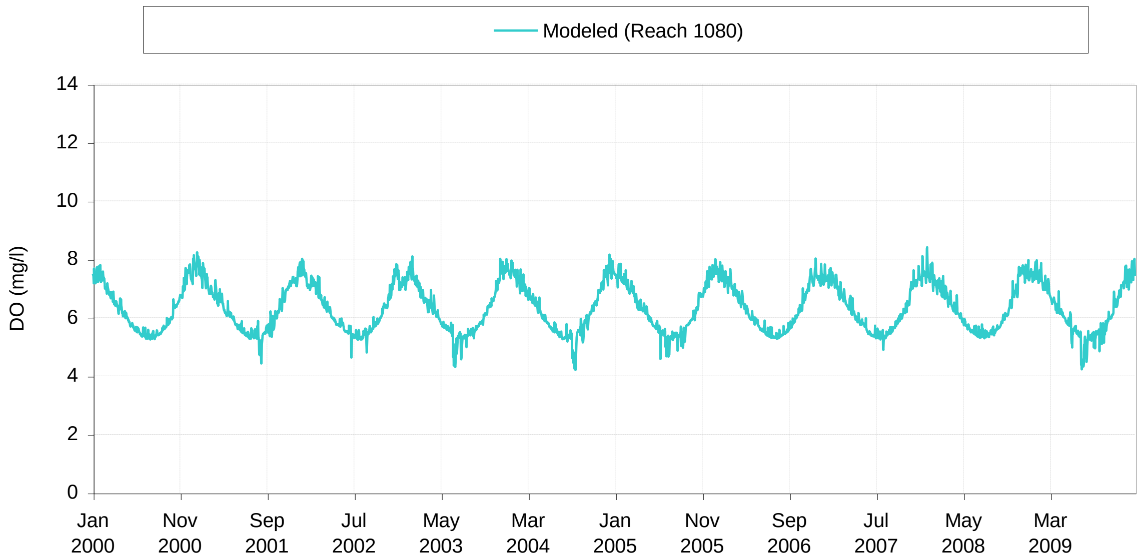


Figure 7.42 Natural condition dissolved oxygen (mg/l) in WBID 1443A

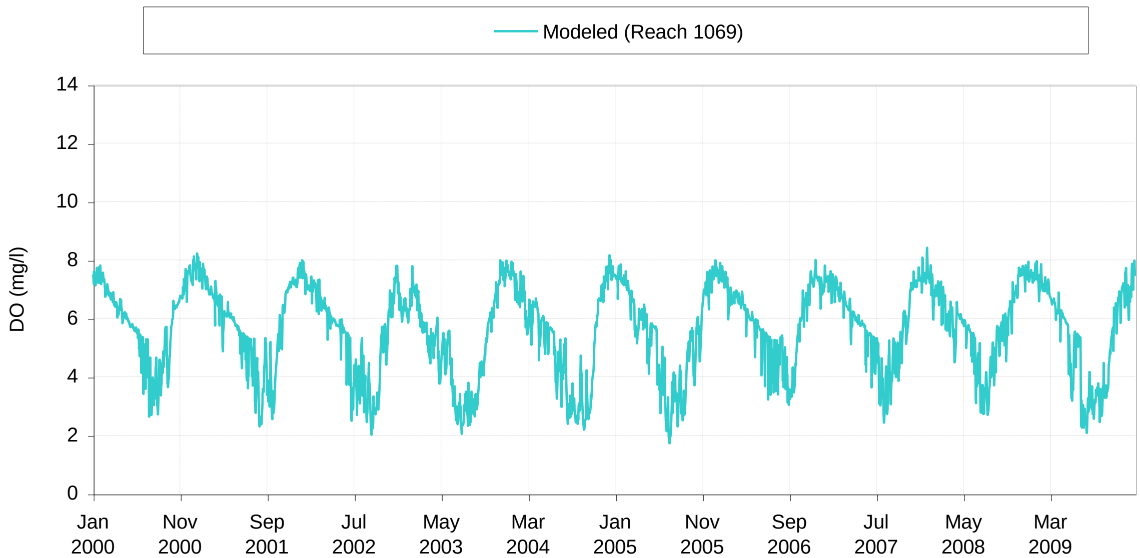


Figure 7.43 Natural condition dissolved oxygen (mg/l) in WBID 1443B

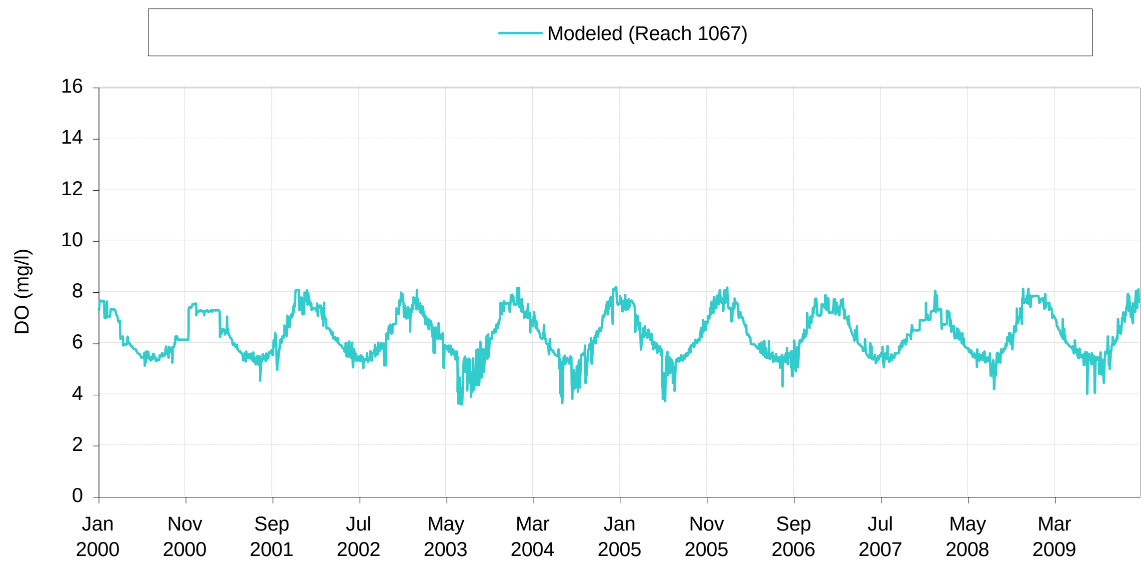


Figure 7.44 Natural condition dissolved oxygen (mg/l) in WBID 1534

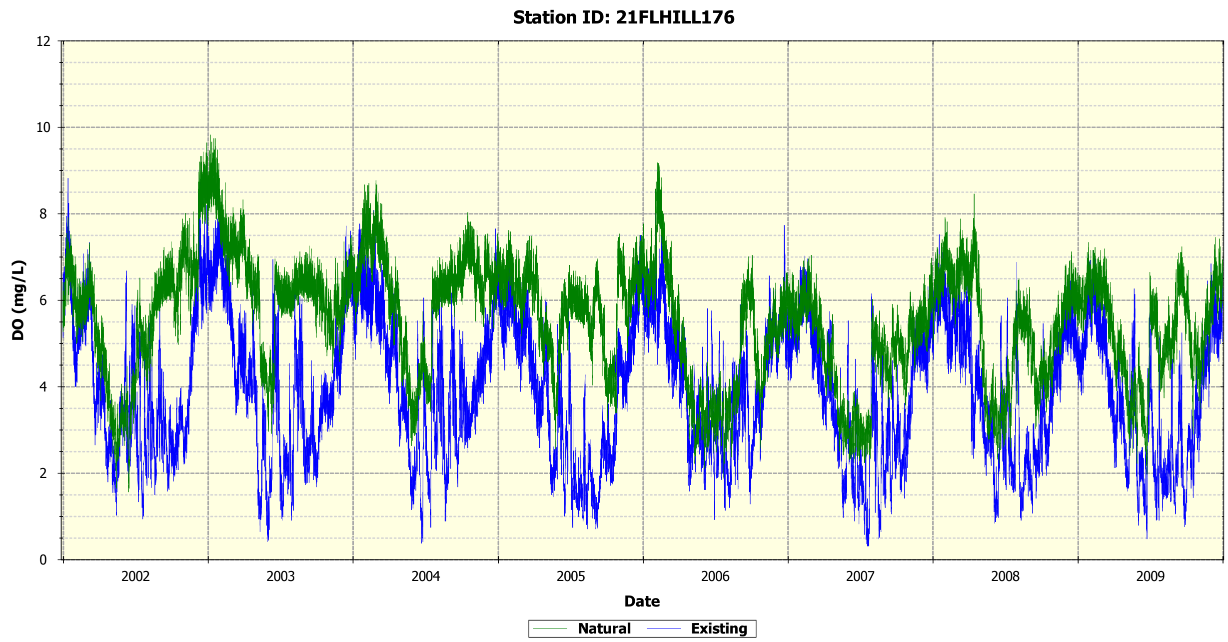


Figure 7.45 Natural condition dissolved oxygen in WBID 1443E

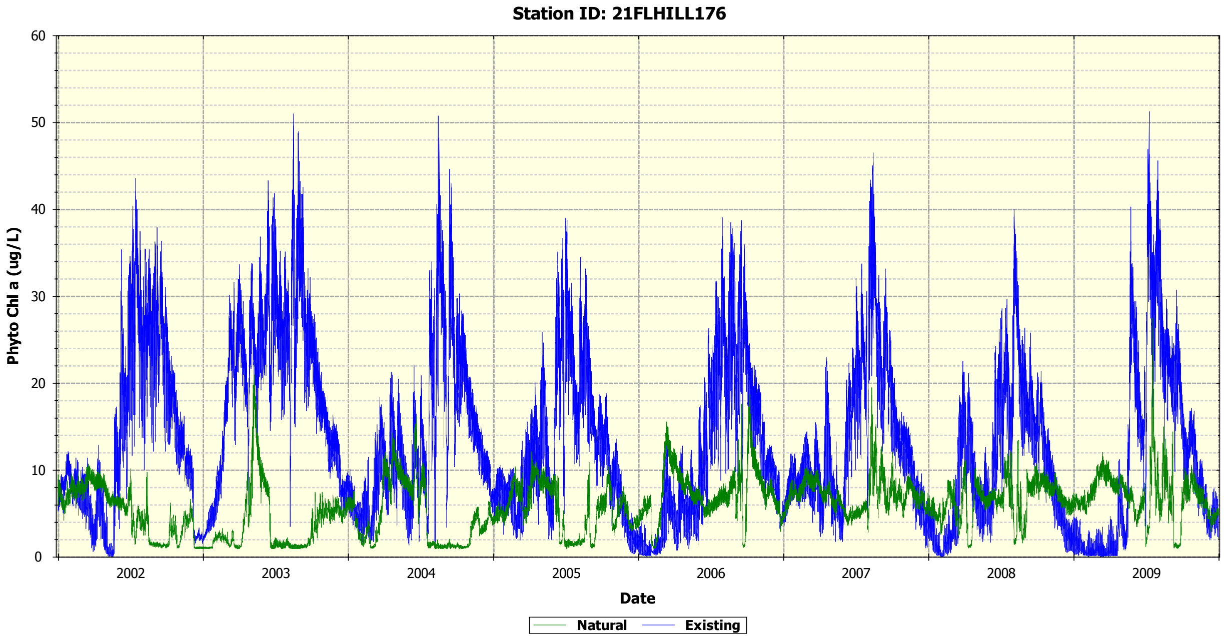


Figure 7.46 Natural condition chlorophyll a in WBID 1443E

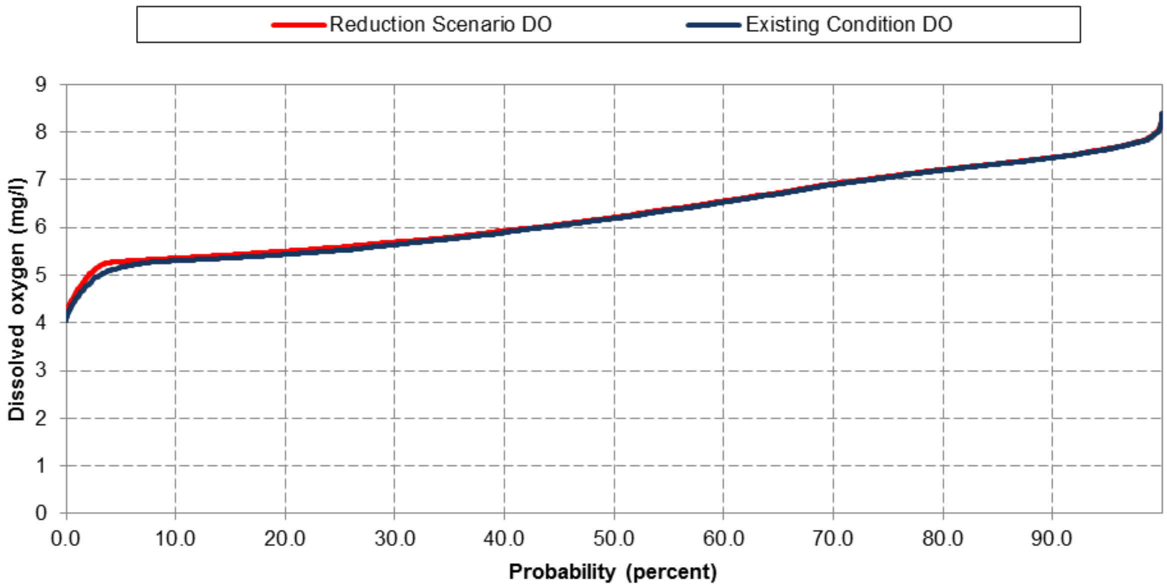


Figure 7.47 Dissolved oxygen concentration cumulative distribution function for WBID 1443A

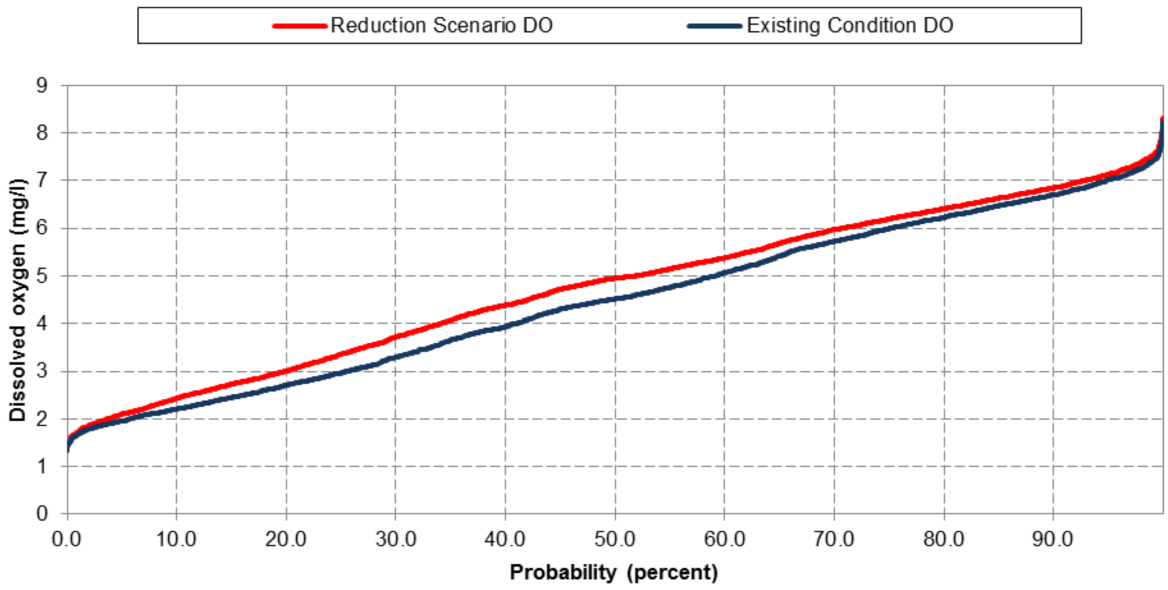


Figure 7.48 Dissolved oxygen concentration cumulative distribution function for 1443B

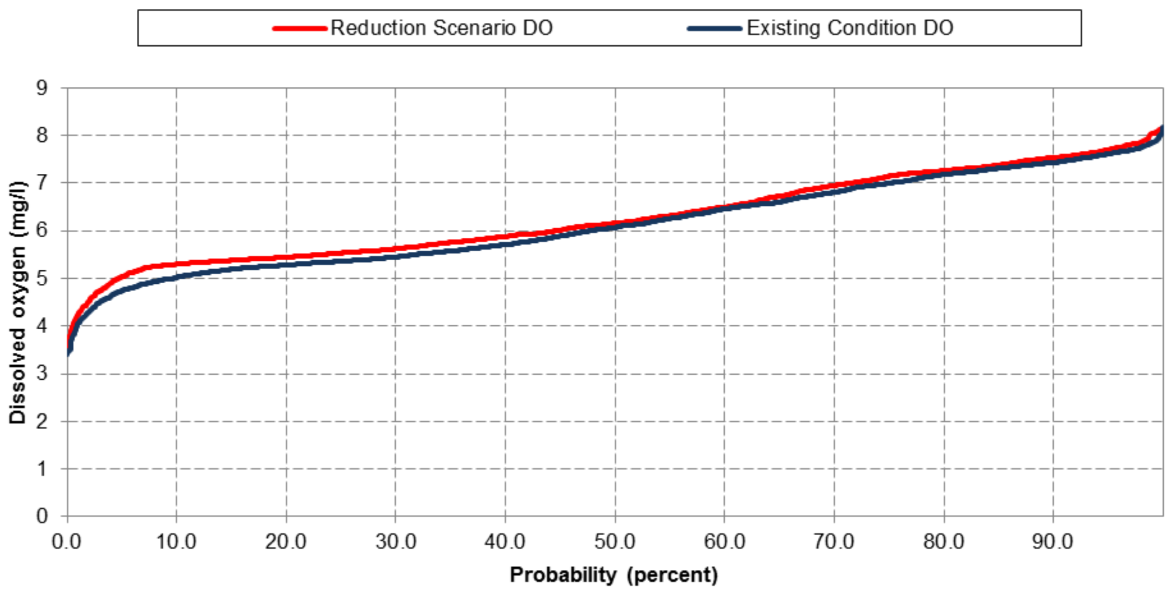


Figure 7.49 Dissolved oxygen concentration cumulative distribution function for 1534

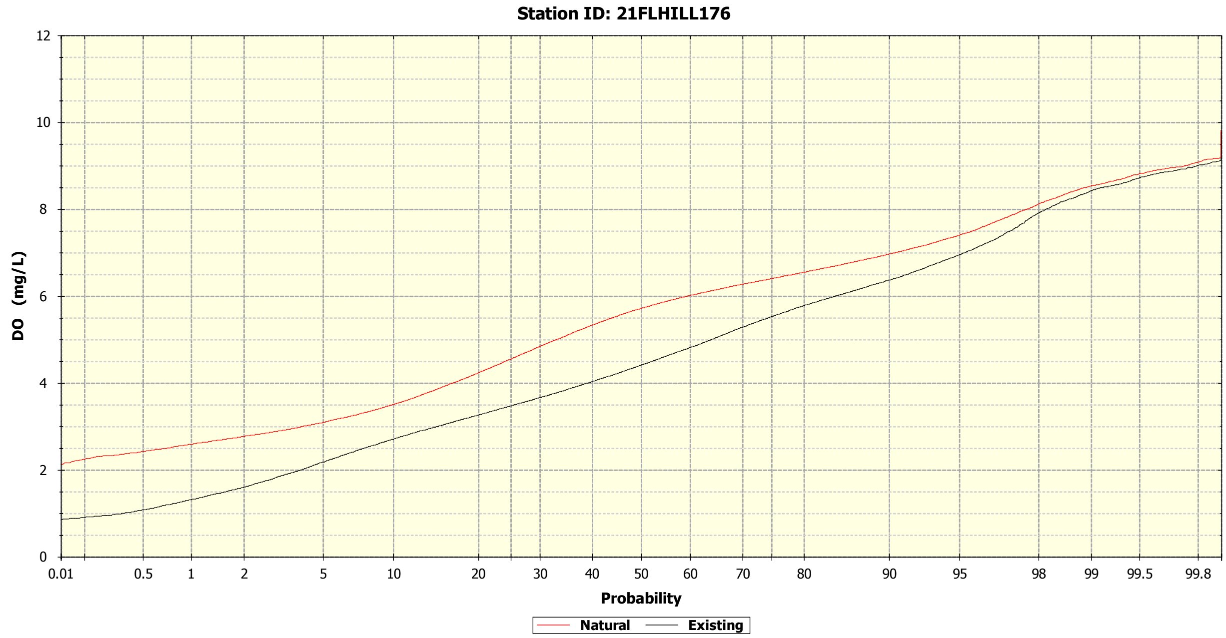


Figure 7.50 Dissolved oxygen concentration cumulative distribution function for WBID 1443E

## 8.0 TMDL DETERMINATION

The TMDL for a given pollutant and waterbody is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody and still achieve water quality standards and the waterbody's designated use. In this TMDL development, allowable concentrations from all pollutant sources that cumulatively amount to no more than the TMDL must be set and thereby provide the basis to establish water quality-based controls. The TMDLs targets were determined to be the conditions needed to restore and maintain a balanced aquatic system. Furthermore, it is important to consider nutrient loading over time, since nutrients can accumulate in waterbodies.

The TMDL was determined for the concentrations and loadings at the outlet of each of the impaired WBIDs, and included all loadings from upstream sources and streams. During the development of this TMDL, it was determined that the natural condition scenario (removal of all anthropogenic sources and land uses) did not meet the Florida standards for DO. The DO was greater during the natural condition run, and nutrient loadings from the natural condition scenario were therefore used to determine the TMDL in accordance with the Natural Conditions narrative rule. By using the natural conditions nutrient loadings for the TMDL, the nutrient reductions also ensure protection of the downstream estuaries. EPA believes that setting the TMDL condition to a natural condition protects both 47(a) and 47(b) of the Florida narrative nutrient standard. It assures that no man induced activities would have caused an imbalance of flora and fauna. Natural background levels are presumed to protect aquatic life. Florida's water quality standards do not allow the abatement of natural conditions, this TMDL represents the lowest level of nutrients that could be established. The allocations for each of the impaired WBIDs for total nitrogen, total phosphorus, and biochemical oxygen demand are presented in Table 8.1 through Table 8.4.

Table 8.1 TMDL Load Allocations for WBID 1443A in the Hillsborough River Basin

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 78,558 | -- | 36,946 | -- | 53% | 53% |
| Total Phosphorus | -- | 7,651 | -- | 1119 | -- | 85% | 85% |
| Biochemical Oxygen Demand | -- | 70,284 | -- | 50,532 | -- | 28% | 28% |

Table 8.2 TMDL Load Allocations for WBID 1443B in the Hillsborough River Basin

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 443,246 | -- | 225,723 | -- | 49% | 49% |
| Total Phosphorus | -- | 53,832 | -- | 8451 | -- | 84% | 84% |
| Biochemical Oxygen Demand | -- | 192,403 | -- | 141,301 | -- | 27% | 27% |

Table 8.3 TMDL Load Allocations for WBID 1443E in the Hillsborough River Basin

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 357,542 | -- | 148,517 | -- | 58% | 58% |
| Total Phosphorus | -- | 78,035 | -- | 6169 | -- | 92% | 92% |
| Biochemical Oxygen Demand | -- | 153,503 | -- | 153,503 | -- | 0% | 0% |

Table 8.4 TMDL Load Allocations for WBID 1534 in the Hillsborough River Basin

| Constituent | Current Condition | | TMDL Condition | | Percent reduction | | |
|---|---|---|---|---|---|---|---|
| | WLA (kg/yr) | LA (kg/yr) | WLA (kg/yr) | LA (kg/yr) | WLA | LA | MS4 |
| Total Nitrogen | -- | 11,132 | -- | 5,054 | -- | 55% | 55% |
| Total Phosphorus | -- | 753 | -- | 130 | -- | 83% | 83% |
| Biochemical Oxygen Demand | -- | 11,855 | -- | 7,640 | -- | 36% | 36% |

### *8.1 Critical Conditions and Seasonal Variation*

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition is the combination of environmental factors creating the "worst case" scenario of water quality conditions in the waterbody. By achieving the water quality standards at critical conditions, it is expected that water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year, and that the TMDLs account for any seasonal change in flow or pollutant discharges, and any applicable water quality criteria or designated uses (such as swimming) that are expressed on a seasonal basis.

The critical condition for nonpoint source concentration and wet weather point source concentrations is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, nutrients build up on the land surface, and are washed off by rainfall.

The critical condition for continuous point source concentrations typically occurs during periods of low stream flow when dilution is minimized. Although loading of nonpoint source pollutants contributing to a nutrient impairment may occur during a runoff event, the expression of that nutrient impairment is more likely to occur during warmer months, and at times when the waterbody is poorly flushed.

## 8.2 Margin of Safety

The Margin of Safety accounts for uncertainty in the relationship between a pollutant load and the resultant condition of the waterbody. There are two methods for incorporating an MOS into TMDLs (USEPA 1991):

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations
- Explicitly specify a portion of the total TMDL as the MOS and use the remainder for allocations

This TMDL uses an implicit MOS since the TMDL targets for nutrients were set to natural background conditions.

## 8.3 Waste Load Allocations

Only MS4s and NPDES facilities discharging directly into lake segments (or upstream tributaries of those segments) are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTPs) and MS4 areas, as the former discharges during all weather conditions whereas the later discharges in response to storm events.

### 8.3.1 Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to wastewater and industrial NPDES-permitted facilities discharging to surface waters within an impaired watershed. There were no significant NPDES permits discharging directly to the impaired WBIDs, therefore no WLA allocations were calculated.

### 8.3.2 Municipal Separate Storm Sewer System Permits

The WLA for the MS4s are listed in Table 8.1 through Table 8.4. Table 8. contains the Table 8.5 MS4 Permits in the impaired WBIDs, their WLAs are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate concentrations coming exclusively from the MS4 areas. Although the aggregate concentration allocations for stormwater discharges are expressed in numeric form, i.e., percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by this TMDL often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

This TMDL assumes for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, this TMDL assumes that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for nutrients for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

All Phase 1 MS4 permits issued in Florida include a re-opener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida may designate an area as a regulated Phase II MS4 in accordance with Rule 62-620.800, FAC. Florida's Phase II MS4 Generic Permit has a "self-implementing" provision that requires MS4 permittees to update their stormwater management program as needed to meet their TMDL allocations once those TMDLs are adopted. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. All future MS4s permitted in the area are automatically prescribed a WLA equivalent to the percent reduction assigned to the LA. The MS4 service areas described in Section 6.1.2 of this report are required to meet the percent reduction prescribed in Table 8.1 through Table 8.4 through the implementation of BMPs.

Table 8.5 MS4 Permits in the impaired WBIDs

| WBID | Segment Name | Phase | Facility Number | Affiliate |
|---|---|---|---|---|
| 1443A | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I C | FLS000015* | Polk County |
| | | I C | FLS000032* | Pasco County |
| | | I | FLS000032 | City of Zephyrhills |
| 1443B | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I C | FLS000032* | Pasco County |
| 1443E | Hillsborough River | I C | FLS000006* | Hillsborough County |
| | | I | FLS000008 | City of Tampa |
| 1534 | Cow House Creek | I C | FLS000006* | Hillsborough County |
| | | I | FLS000009 | City of Temple Terrace |

*FDOT

## 8.4 Load Allocations

The load allocation for nonpoint sources was assigned a percent reduction in nutrient concentrations from the current concentrations coming into the WBID addressed in the TMDL report.

# 9.0 RECOMMENDATIONS/IMPLEMENTATION

The initial step in implementing a TMDL is to more specifically locate pollutant source(s) in the watershed. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

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